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Vol. 42 AUGUST, 1956 No. 8

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1 Williams Round Buccal Tubes — for .036" or .040" diam. wire.

2 Williams No. 2 Arch Wire — for labial or lingual arches. Round (.036" to .040" diam.) or rectangular (.022" x .028").*

3 Williams No. 1 Ortho Wire — for intermaxillary hooks, adjustable spring stops, etc. (.020", .022", .036" or .040" diam. wire).*

4 Williams Anterior Bands — anatomically contoured — 18 graduated sizes, .004" x .160" wide.

5 Williams Open Bracket Tubes — for .032", .036", or .040" diam. wire.

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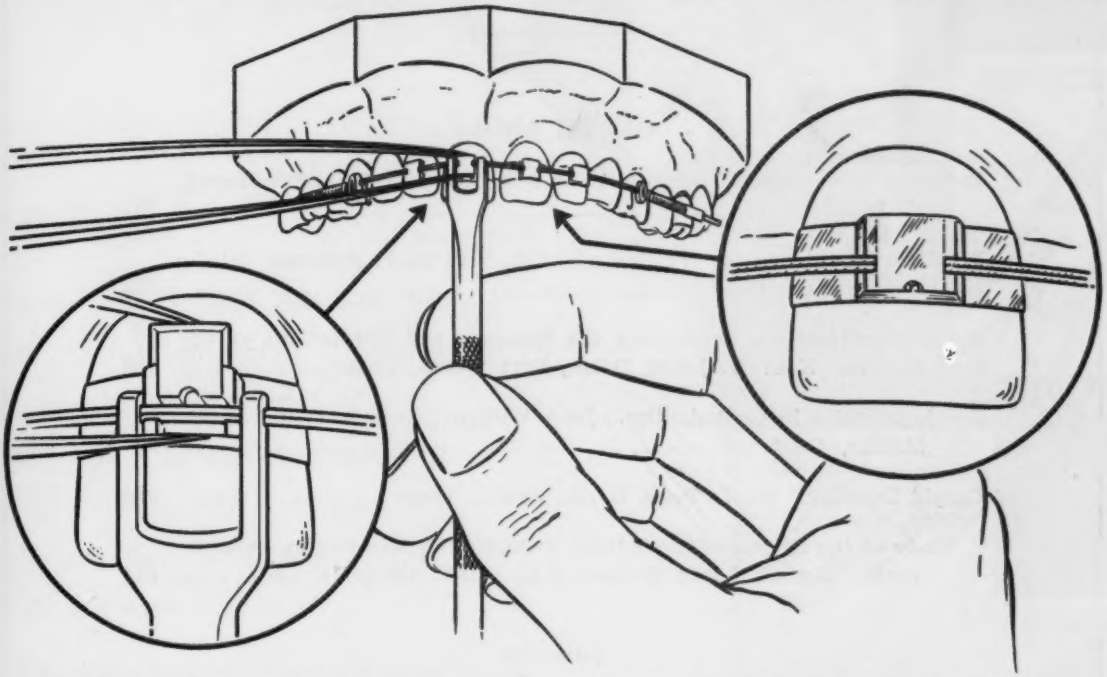
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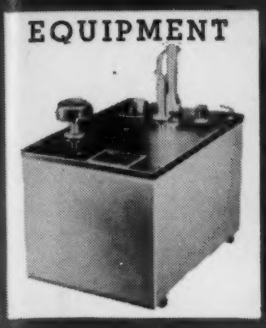
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Dear Doctor:

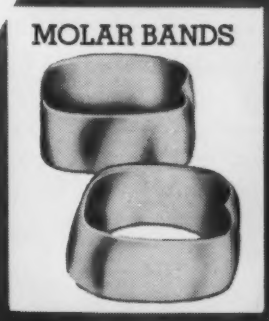
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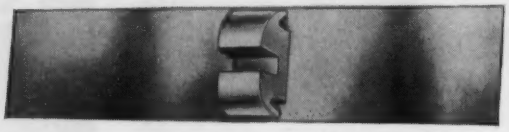
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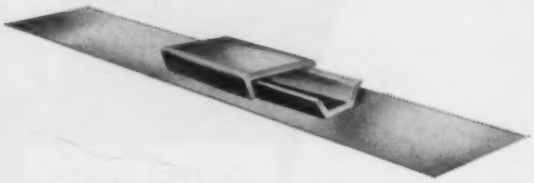
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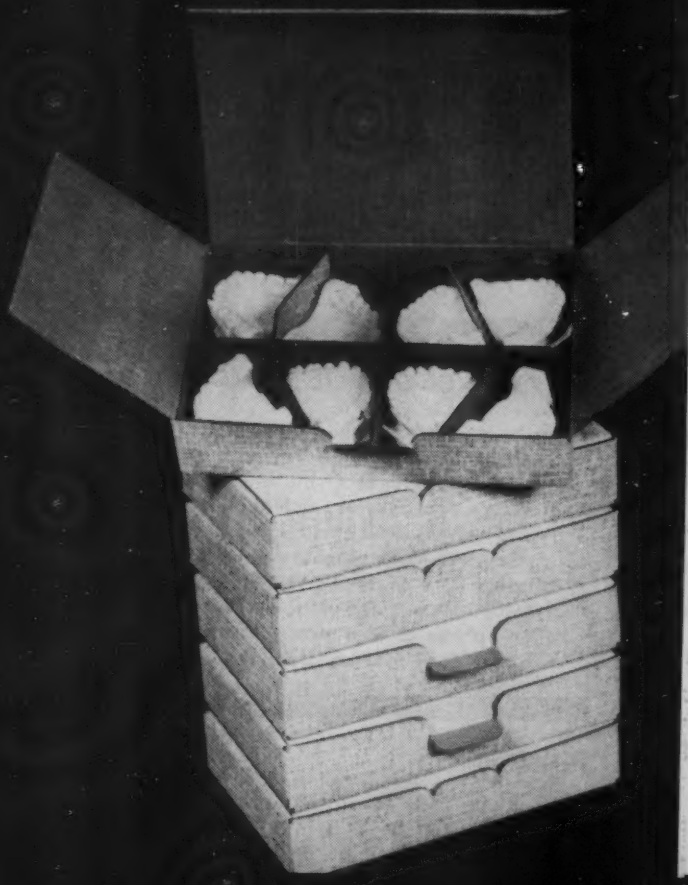
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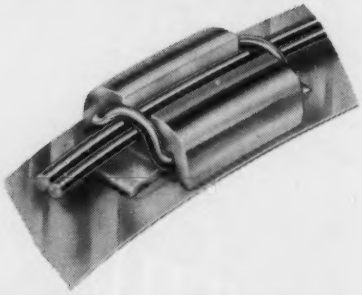
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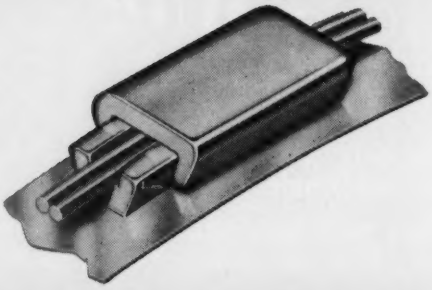
TWIN ARCH TIE BRACKETS

The ultimate in a tie type bracket. These improved brackets offer new strength, smoothness, attractiveness and practicality. The pre-curved flange and extended wings provide distinct working advantages. Design-wise, sufficient clearance has been allowed between the base of the twin-wire slot and welding flange to eliminate possibility of coil spring binding.



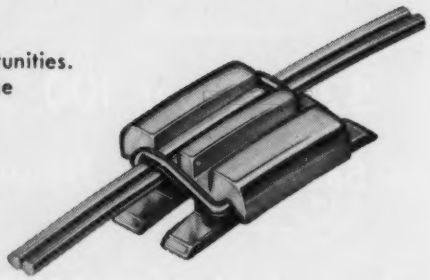
TENSION-LOCK BRACKETS

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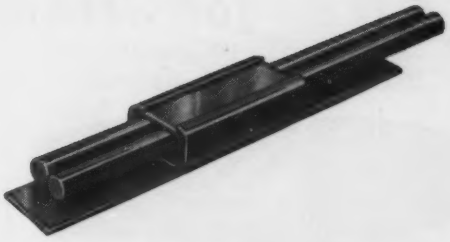
The multi-phase philosophy opens up a new realm of opportunities. These brackets, used in twin wire tie techniques, offer all the basic advantages of the Unitek twin arch tie brackets. In addition, they accommodate both the edgewise and universal techniques, enabling the orthodontist to alter treatment procedures without band removal or attachment of auxiliaries. They permit any technique or combination of techniques during any phase of treatment, offering major advantages for the transfer patient.



APPLIANCES FOR TWIN WIRE TECHNIQUES

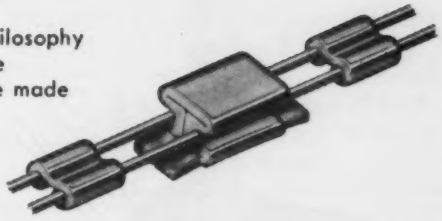
YOST TWIN WIRE ATTACHMENTS

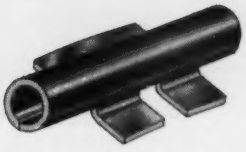
The Sliding Sleeve Attachment, exemplifies design refinement in its truest sense.
It is significant to note that while gaining numerous basic advantages, overall bulk has been appreciably reduced.
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Links then hold arch wire in the desired relationship.
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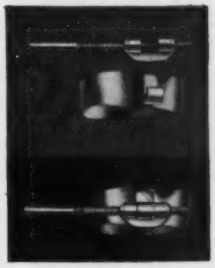
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TUBES AND SHAFTING

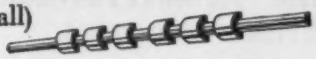


TUBES — HALF ROUND

DL-8, length .08″; DL-10, length .10″ (Inside dimensions .032″ x .064″; .012″ wall)

DL-10H, length .10″ (Inside dimensions .032″ x .064″; .014 wall, extra heavy)

DS-8, length .08″; DS-10, length .10″ (Inside dimensions .020″ x .040″; .010″ wall)



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  .020″ .022″ .025″
- Ribbon Arch Wires
  .022″ x .028″ .022″ x .036″
- Rectangular Arch Wires
  .022″ x .025″ .022″ x .028″
  .022″ x .036″
- Square Arch Wires
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5 dwt. container of solder in wire form. 26 ga. and 28 ga.

SOLDER SHAPES

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- Attachment Solder, .560 fine
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- Solder Ferrules, .560 fine
  Each piece .032″ inside diam. x .003″ wall.
- Solder Disks, .560 fine.



ROUND TUBES

R-025, length .25″, fits .040 wire
R-125, length .25″, fits .036 wire
R-135, length .35″, fits .036 wire
R-145, length .45″, fits .036 wire
R-220, length .20″, fits .030 wire
R-310, length .10″, fits .025 wire
Wall thickness of all around tubes is .012″.

RECTANGULAR TUBES

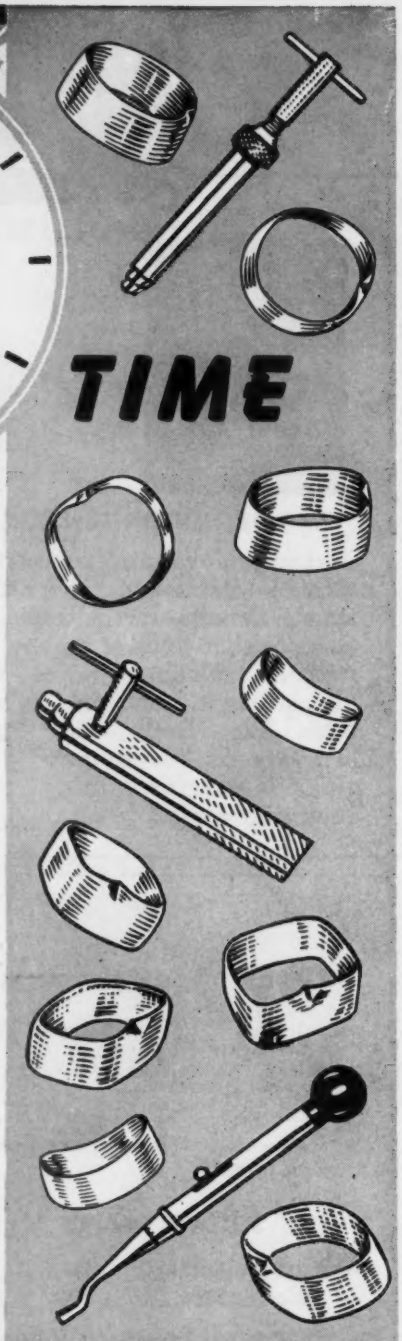
.022″ x .028″, 5/16″ long



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The above is a photograph of the Past-Presidents' Luncheon at the meeting of the American Association of Orthodontists in New Orleans, Louisiana, March 17, 1942. The 1942 meeting was the Pan-American meeting, which many orthodontists from Latin-America attended. The meeting at that time was under the direction of President Claude Wood of Knoxville, Tennessee.

The next meeting in New Orleans will be held May 13 to 16, 1957, under the direction of Dr. A. C. Broussard, A.A.O. President, of New Orleans.

Past-presidents pictured at the 1942 luncheon are, left to right: H. C. Pollock, St. Louis, Missouri; Harry A. Allshouse,† Kansas City, Missouri; Claude R. Wood, Knoxville, Tennessee; James D. McCoy, Beverly Hills, California; C. C. Howard,† Atlanta, Georgia; Joseph D. Eby, New York, New York; Brigadier General Leigh C. Fairbank, Washington, D. C.; Oren A. Oliver, Nashville, Tennessee; Henry U. Barber,† New York, New York; William A. Murray,† Evanston, Illinois; Oliver W. White, Detroit, Michigan; Charles R. Baker, Evanston, Illinois; Harry Kelsey,† Baltimore, Maryland; John J. Mershon,† Philadelphia, Pennsylvania; Ralph Waldren,* Newark, New Jersey; and Paul G. Spencer,* Boerne, Texas.

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*Retired.

†Deceased.

American Journal

of

ORTHODONTICS

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VOL. 42 AUGUST, 1956 No. 8

Original Articles

DIVERSITY OF APPLIANCE THERAPY

DONALD D. OSBORN, D.M.D., PROVIDENCE, R. I.

OVER the past decade the advances made in perfecting orthodontic appliances and the techniques of their construction and manipulation have led us to feel that we have reached the Utopia of this phase of our specialty. Along with this, but perhaps a few paces behind, has come increased knowledge in the biologic, myofunctional, and other collateral aspects of orthodontic therapy. It would seem, therefore, that with the diverse tools which are now available the time has come when we should strive to explore into the role of each and determine when to allow each to do its part unhampered by the others, and when one part should be directed to assist the others.

This, I am sure, is the aim of orthodontic teaching in the graduate and postgraduate university training of today. To augment this training, the young orthodontist is in need of years of clinical experience, as in all branches of medicine, before he can acquire the judgment to differentiate between reality and wishful thinking. Before placing appliances, however, it should be borne in mind that several factors exist, any one of which may have a bearing on the appliance therapy involved. The first of these is growth, or the growing power of the patient. Many of the changes which take place in the face and jaws are the result of that growth, not of our treatment. Therefore, should growth be allowed to proceed entirely free from mechanical help or interference? If so, for how long? On the other hand, if it is felt that something

Presented before the American Association of Orthodontists, Boston, Massachusetts, May, 1956.

may be gained by mechanical therapy during the growth period of the patient, proper judgment must be exercised in choosing the type of appliance which may assist, but not interfere with, growth. This might call for a very simple type, sometimes no more than a bite plate.

Again, we may feel that a child has a misguided growth pattern. If we allow this to continue until the permanent teeth erupt and then resort to extraction, does this seem justifiable in most cases? Perhaps a little treatment at the correct time to influence the pattern of coordinated growth could result in avoiding many mutilations. Extraction as a compromise can always be resorted to later if necessary. To quote from Brodie,[1] "Until we can read individual growth curves and make accurate predictions as to the cessation of growth, we have no recourse but to wait for the development of the full dentition, except for the third molars, before deciding that the arch will not hold its full complement of teeth. Extraction prior to this is guesswork."

Another problem related to growth is facial patterns. How much should we try to alter them? It is obvious that maxillary and mandibular prognathisms should be corrected to establish a semblance of facial balance, while an overgrowth or underdevelopment of the mental protuberance cannot be altered. We are endeavoring to correct a retarded or underdeveloped facial growth in malocclusion so that a pleasing symmetry of beauty and form as well as an efficient masticatory apparatus may be brought about, bearing in mind the fact that a well-balanced face is as important as exact alignment of the teeth. What might be termed a bimaxillary protrusion during periods of growth may be perfectly normal for the individual patient in adult life. Consequently, I find few bimaxillary protrusion cases in my practice which I feel justified in treating as such, when the occlusion is good, for the sake of a slight reduction in mouth fullness as balanced against the possible damage to roots, periodontal membrane, and surrounding alveolus over a period of time. Again I quote from Brodie[1]: "Nature has cast each of us in a different mold, and to attempt deliberately to alter the type of face is presumptuous."

Over the years I have used many appliances, keeping some and discarding others, as have most men practicing for some time. Emerging from this period of trial and error, I have found myself with a specific number of appliances, but used in variation, being ever cognizant of the growth problem of the patient. To my mind, it is in this phase of appliance therapy that the greatest errors are still made in orthodontics. I am sure that all of us who have practiced orthodontics for any appreciable length of time have been confronted with referred cases under treatment with appliances which sometimes leave us completely puzzled as to what the former orthodontist could ever have expected to accomplish with them. The appliances are either so simple that with the anchorage problem present the case will go on forever with no benefit (to the child at least), or the patient is all strapped up with an appliance to correct a condition that needed far less hardware. It is my strong

conviction that when a case calls for a so-called simple appliance in its treatment, no other should be placed on that patient. On the other hand, when an anchorage problem calls for a multibanded appliance, the operator should have had the training and should possess the ability to employ that type of appliance, and the case should be so treated. Too often the appliances in either of these categories are condemned for no reason other than lack of knowledge or inability to handle them, and in each instance the patient is the loser!

What, then, are the appliances which, in my hands, I have found best suited in the application of appliance therapy? Basically, they are the labial arch wire, with or without fixed lingual arms, the plain or loop lingual arch

Fig. 1. Fig. 2.

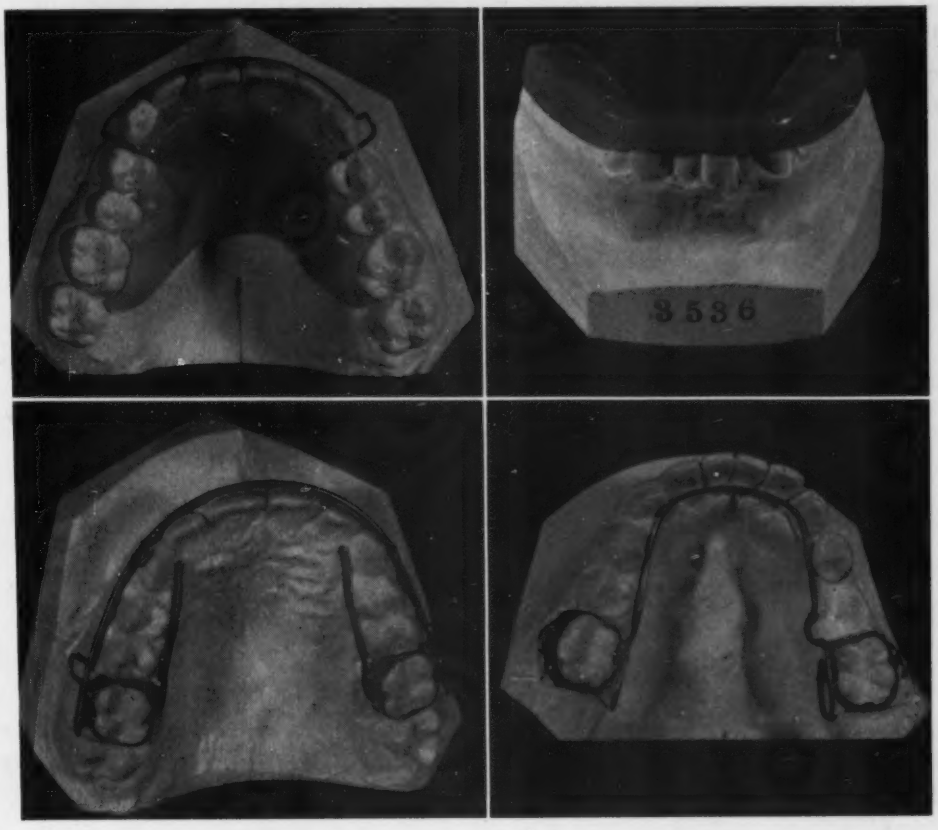


Fig. 3. Fig. 4.

wire, and the edgewise mechanism. Of course, there are other good appliances in use today, but I have found that the ones mentioned can be adapted to all cases in an efficient manner. As it would be a colossal undertaking to cover all types of cases in an article of this sort, only typical cases treated with the appliance therapy involved can be covered.

First, it might be advisable to explain the different appliances of my choice in order that reference to them in the text will be understood.

The bite plate (Fig. 1) is used to aid in opening the bite or encouraging the mandible to assume a more forward position when points of interference have been removed. It is worn all the time, even when eating, in order to obtain full efficiency.

The bite block (Fig. 2) is used on the lower teeth to move one or more upper anterior teeth labially when lingually locked. This also is worn at all times, and the patient is warned to keep it clean, especially after meals.

The labial arch wire (Fig. 3) with attached lingual arms is familiar to most of us. In some cases, when it is used to move the upper molars distally without any expansion, lingual arms are omitted.

Another popular appliance (Fig. 4), with which I am sure you are all familiar, is the loop lingual arch wire with intermaxillary hooks soldered to the molar bands. And very important is the anterior spur, suggested by Oren Oliver, placed to discourage the tongue from lifting the arch wire, which could result in breakage or forward movement of the buccal teeth when elastics are being worn.

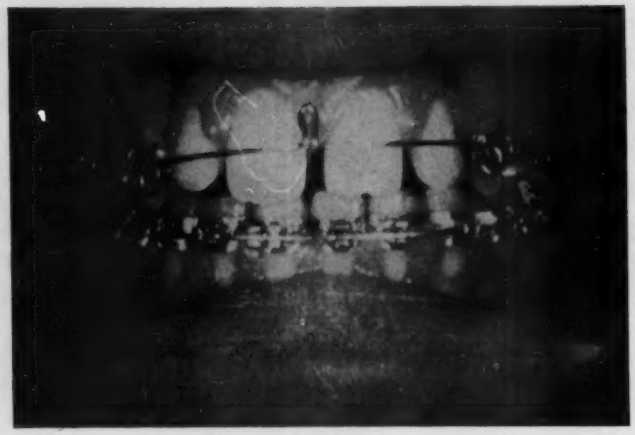


Fig. 5.

Fig. 5 shows an appliance which we, of course, know as the Angle edgewise mechanism. Without the four anterior bands, it will be referred to as a junior edgewise appliance. The loop in the center of the arch wire is used while the four anterior teeth are being retracted, usually after distal movement of cuspids in first premolar extraction cases.

As can be seen from the foregoing, there is nothing new in appliances; but we have a variety with which to work, thus allowing the opportunity to fit the appliance to the individual patient. To carry this thought one step further, I shall quote from Jackson[2]: "The essence of any problem consists in knowing *what* to do, *when* to do it, and *how* to do it."

The first case (Fig. 6) is that of a 13-year-old boy, somewhat retarded in dental development. In this case there are four points to consider: (1) the deep overbite, (2) a missing lower incisor, which does not show in this photograph, (3) the slightly distal relationship, and (4) the buccoversion of both

maxillary first premolars. A bite plate was the only appliance used, except for what Rogers[3] refers to as the "living appliances"—the masseter-temporal and pterygoid group of muscles. These were strengthened through diligent exercises, thereby aiding in vertical growth of the buccal segments and repositioning (Fig. 7) of the mandible. Permit me at this time to repeat that many of the changes which take place are the result of growth, not of our treatment.



Fig. 6.



Fig. 7.



Fig. 8.



Fig. 9.

The next case (Fig. 8) looks quite normal at first glance. However, the patient, aged 19 years, complained of a "clicking" in the left temporomandibular joint, which she found very annoying whenever the teeth occluded. Upon close examination, it was noted that the mandible had a slight distal positioning on the left side, so a bite plate was inserted to open the bite a little and encourage the mandible to assume a more forward position. Relief was experienced almost immediately, but after one month the "clicking" returned to a lesser degree. The bite plane was raised a trifle, and since then the discomfort has not recurred (Fig. 9). For the past nine months the plate has been worn at night only and will soon be discontinued.

The case shown in Fig. 10 is presented to illustrate the use of the bite block to hold the bite open while moving the maxillary lateral incisors labially. The bite block was placed on the mandibular arch at the beginning of treatment, while an edgewise appliance was used on the maxillary arch. After the upper lateral incisors were moved labially into position (Fig. 11), the bite block was replaced with a loop lingual appliance to align the lower anterior teeth.



Fig. 10.



Fig. 11.

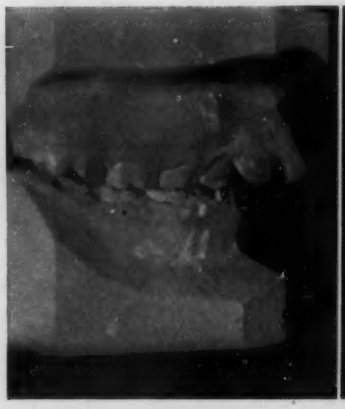


Fig. 12.



Fig. 13.

The following group of four cases is presented to illustrate the importance of stepping in at the correct time, even in mixed dentitions, with a simple appliance, obviating any treatment on the permanent dentition later. The appliances used were the labial arch wire with fixed lingual arms on the maxillary arch and the loop lingual arch wire on the mandibular arch, supplemented with intermaxillary elastics. I would like to emphasize that these four patients were treated between the ages of 8 and 10 years, and that all had mixed dentitions, while the permanent dentitions, which will be shown, are the finished results with no secondary treatment.

The first patient of this series (Fig. 12) was an 8-year-old boy. After one year of treatment with the labiolingual technique, anterior edgewise bands were added, and the active work was completed in three more months, at

which time the maxillary appliance was replaced with a bite plate. Masseter-temporal exercises were also instituted at this time to strengthen that group of muscles, for in this type of case they are often lacking in development. Three years later, with no further treatment involved, the dental apparatus appeared quite normal (Fig. 13).



Fig. 14.



Fig. 15

Fig. 16.

Fig. 17.

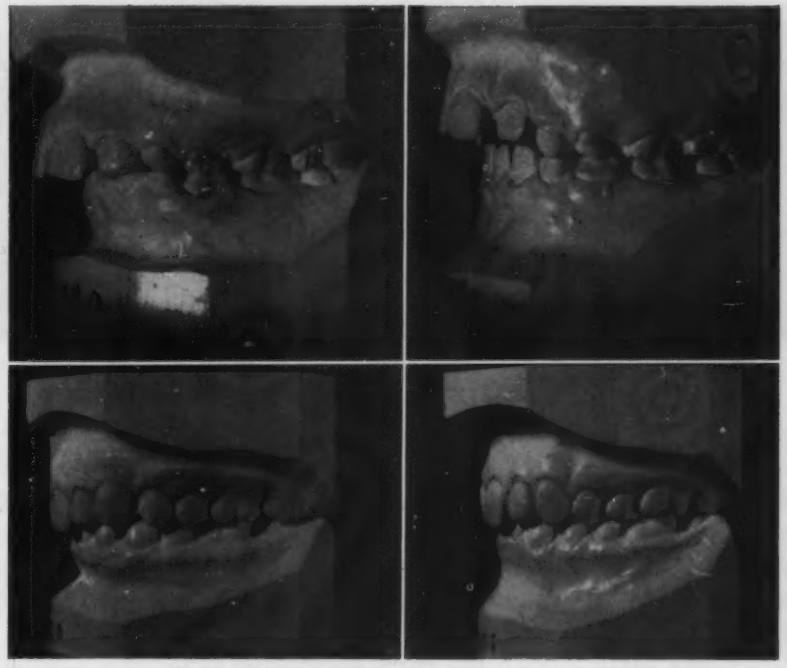


Fig. 18.

Fig. 19.

The second patient (Fig. 14) was a boy, also 8 years of age. After five months of treatment, anterior bands with McCoy open tubes were added. After a total of fifteen months of active treatment, a bite plate replaced the maxillary appliance, and again masseter-temporal exercises were given. The final result, with no further treatment (Fig. 15), is similar to the last case.

The third and fourth patients in this group are a brother and sister, four years apart in age. The boy (Fig. 16), 9 years old when first seen, presented a deep overbite; while the girl, aged 10 (Fig. 17), had a tendency toward an open-bite. Both cases were Class II, Division 1. Each was treated with a labiolingual appliance, to which upper anterior bands were added after a few months. Fig. 18 shows the boy three years out of retention and Fig. 19 shows the girl with no tendency to an open-bite. Masseter-temporal exercises were given in both cases.

In reviewing these last four cases, the labial arch wire was used without anterior bands until the maxillary buccal teeth were moved distally in order to guard against forward displacement of the maxillary incisors. The lingual arch wire was used as a retainer for one year on the mandibular arch in only one case of this group, while the other three required no retention. All four patients were given masseter-temporal exercises, for I feel that this is an important adjunct in the retention of this type of malocclusion when treated with the mixed dentition. Let me repeat that none of these patients required a secondary period of treatment when the remaining permanent teeth erupted, as normal growth and development proceeded unhindered after removal of the undesirable factors.



Fig. 20.



Fig. 21.



Fig. 22.

The next patient, a 9-year-old girl (Fig. 20), was not included in the previous group (although hers is also a mixed dentition Class II, Division 1 case), since she had both lower lateral incisors missing. A labial appliance with fixed lingual arms was placed on the maxillary arch and a loop lingual arch wire was placed on the mandibular arch. After two months of treatment, edgewise bands were added to the upper four anterior teeth. Active treatment was completed in one year, at which time the appliance was replaced with a bite plate. With the work completed (Fig. 21), I consider it a fair compromise without tooth replacement (Fig. 22), although the buccal occlusion is not perfect. The only other comment that I have regarding this case is that no secondary treatment was necessary.

The next case (Fig. 23) is that of a 7-year-old boy who was brought to the office by his father, a dentist. With one hand, the father was holding the

child, while in the other he held an upper central incisor. Both buccal segments presented a distal relationship. It was decided to correct the distal occlusion on the left side but to leave the right side as presented, allowing the upper right lateral incisor to replace the lost tooth (Fig. 24). A junior edgewise appliance was placed on the maxillary arch, and a loop lingual arch wire was placed on the mandibular arch. An intermaxillary elastic was used on the left side only. After fifteen months, a retaining plate was placed on the maxillary arch, but the boy lost this in four months. Shortly thereafter, it was decided to use a plain labial arch wire again as a retainer due to the patient's poor cooperation at 8 years of age. After one and one-half years, a bite plate replaced the labial arch wire as a retainer and was worn until all the permanent teeth erupted, at which time the patient's father placed a jacket crown (Fig. 25) over the lateral incisor.



Fig. 23. Fig. 24. Fig. 25.

Not all patients coming to our offices present mixed dentitions; some have all their permanent teeth when first seen. Many of these, I feel, require full edgewise appliances, but this article will touch only lightly on that phase of orthodontic treatment, for there is an abundance of printed material concerning its application. Although I find it a most gratifying appliance to use on permanent dentitions, there are times when a simpler method of treatment should be considered.

The case shown in Fig. 26, that of a 14-year-old boy, is one which I felt should be treated with a simpler type of appliance therapy. There was a distal relationship on both sides, plus a deep overbite and a supraversion of the upper right buccal teeth. A bite plate was used on the maxillary arch, and a plain labial appliance with lingual arms was placed on the mandibular arch. When the teeth began to respond to treatment, a junior edgewise appliance was added to the maxillary arch (the wires were removed from the plate so that it could also be worn), and an elastic was added to the right side from the buccal of the upper molar to the lingual of the lower one. Shortly thereafter, the lower labial arch wire was replaced with a lingual appliance, while intermaxillary elastics were worn on both sides to correct the mesiodistal relationship. The entire active treatment required fifteen months, after which a bite plate was employed, together with masseter-temporal exercises. The plate

was worn for fifteen months; Fig. 27 shows the case one and one-half years out of retention. No retainer was ever used on the lower arch, which illustrates the importance of natural retention by strengthening of the musculature.

Fig. 26.



Fig. 27.



Fig. 28. Fig. 29.

At times, most of us find it necessary to resort to extraction for one reason or another. Many papers have already dealt thoroughly with extraction of four premolars; however, not much has been said with regard to upper first

premolar extractions only, and yet I believe that they have a definite place in our therapy. The following two cases were chosen to illustrate this point.

The first case of upper first premolar extractions presented a blocked-out upper left cuspid (Fig. 28) and a distal locking of the buccal teeth on both sides. After extraction of the upper first premolars, a labial appliance was placed on the maxillary arch with auxiliary loop springs for distal movement of the cuspids. A loop lingual arch wire was used on the lower arch with intermaxillary elastics to reinforce the upper molars against forward displacement. When the upper cuspids were distally in position, a junior edgewise appliance replaced the upper labial arch wire to retract the anterior teeth. This was followed by a full edgewise appliance on the maxillary arch for final rotations and alignment. Active treatment required fifteen months; Fig. 29 shows the case one year after appliances were removed.



Fig. 30.



Fig. 31.

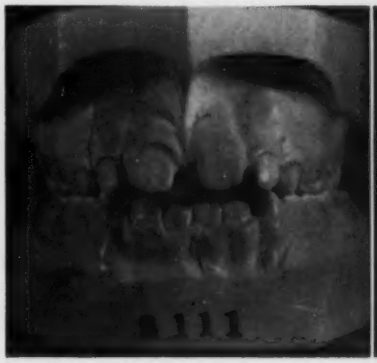


Fig. 32.



Fig. 33.



Fig. 34.

The other case presented a Class II, Division 1 occlusion with a deep overbite (Fig. 30). A bite plate with buccal loop sections was placed on the maxillary arch after the extraction and a lingual arch wire was used on the mandibular arch. Intermaxillary elastics were added to help the distal movement of the upper cuspids. When they had been moved distally into position, the loop sections were replaced with a full arch wire to retract the upper

anterior segment. Edgewise bands were then added to those teeth (making a full edgewise appliance) to finish the case. After fifteen months of appliance therapy, a retaining plate was worn for an additional fifteen months. Fig. 31 shows the case one year out of retention.

When I feel that extraction of all four first premolars is necessary, light appliances are not relied upon, but the Angle edgewise mechanism is employed on both arches.

The last case (Fig. 32) was that of a girl, 9 years of age, who presented an open-bite resulting from a tongue habit. No active treatment was planned until the permanent teeth erupted, but tongue exercises were given to help reduce the open-bite (Fig. 33). This is also a case in which I felt that a full edgewise appliance was required on both arches to bring about this result (Fig. 34).

In the presentation of these cases, I purposely have not gone into full treatment with complete photographs and x-ray pictures, for the purpose of this article is to illustrate the diversity of appliance therapy. Versatility of appliances, properly used, is essential if we are to recognize patients as individuals, while muscular therapy should not be overlooked as an aid in many cases. Perhaps one more thought, lest we forget, should be given the forces of growth—let them help us in our endeavor to do all we can for our patients, for as Dr. Angle has often been quoted as saying: "There is only one best way."

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PRACTICAL METALLURGY FOR THE ORTHODONTIST

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METALS are very remarkable materials. Consider their ability to be rolled into sheets as thick as the hulls of ships or as thin as gold and aluminum foil; to be drawn into wire cables supporting bridges or into fine strands, one-half the thickness of a human hair, for delicate electronic instruments; to be softened by heat and hardened by cold-working. Metals are cast into dental inlays and molded into giant steam shovels. They resist wear and corrosion; they conduct heat and electricity; they may be joined or machined; they have luster, yet are generally inexpensive. Finally, metal can be shaped into the myriad of attachments, arch wires, and instruments that comprise the entire armamentarium which permits the technical procedure of orthodontics.

In Nature, metals rarely occur in the pure state, but are found as ores, which may be rock, sand, earth, or mud. Considering the fact that some ores contain only 1 per cent of desirable material, appreciation is gained for the fine product that is delivered to the orthodontist, and perhaps a little more tolerance may be given the occasional faulty piece that appears. Numerous steps in refining and alloying have gone into producing specific wire and band material.

This article will attempt to describe, in limited technical terms, the changes in structure of metal when it is converted into an orthodontic appliance. The common causes of breakage, as well as precautions for their avoidance, will be pointed out. To aid in this description, a group of microphotographs have been prepared, including those of spot-welded joints and soldered joints. A brief discussion on the method of specimen preparation is included.

THE CRYSTALLINE STRUCTURE OF METAL

Crystals or grains of metals and alloys are composed of billions upon billions of atoms regularly arranged in a space lattice that may be pictured as similar in arrangement to a bubble bath. The "pile of oranges" design is one of the more common patterns of space lattice. Crystals of different metals vary in size from those that can be seen with the naked eye to those that require high-powered magnification. The shape of some crystals is similar in appearance to rock candy or snowflakes; other crystals have a more fiberlike of filament character.[1]

This thesis, which was given as a partial fulfillment of the requirements for certification by the American Board of Orthodontics, is being published with the consent and the recommendation of the Board, but it should be understood that it does not necessarily represent or express the opinion of the Board.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1.—A satisfactory joint of gold alloy wrought wire and solder. There is a slight amount of narrowing at the wire's end, indicating some solution of the wire in solder. (Magnification, ×100; reduced ⅔.)

Fig. 2.—The soldered joint shown in Fig. 1 at a magnification of ×200 (reduced ⅔).

Fig. 3.—A small section of the preceding soldered joint showing the dark intermediary area of fusion. The fibrous nature of the grains in the wrought wire may be contrasted to the crystalline dendrite nature of the solder.

Fig. 4.—The soldered joint shown in Fig. 3 at a magnification of ×400 (reduced ⅔).

UME TIGHTLY BOUND

When the surface of metal is etched with an acid various depressions and boundaries appear, revealing the outline of individual crystals. The term "grain structure" refers to this surface arrangement. Metal structure may be described as coarse-grained or fine-grained; there may be grain growth or grain distortion. In general, the smaller the grain size, the more tenacious the structure. The coarse-grained metal is more ductile than a fine-grained one. When metal fractures, the line of parting is through the grains rather than between them. At moderate temperatures the material of the grain boundary is harder than that of the grain, but at high temperatures the area of the grain boundary is the first to weaken.[2]

SOLDERED JOINTS

Gold Alloys.—Figs. 1, 2, 3, and 4 show a union of two gold alloy wires with a gold alloy solder. One sees the desirable qualities in a strong joint. The fine tapering edge of the solder is evidence that the solder ran freely. There is some solution of the vertical wire in the solder as seen by the reduced diameter. The dark circular areas in the solder represent voids caused by oxide inclusions or gas inclusions. These are kept at a minimum by keeping parts to be soldered free of impurities and by not overheating.

The difference in appearance and physical character of grain structure of the wrought wire and cast solder is clearly shown. The grain structure of the wire has a long, threadlike, fibrous nature produced in the original drawing of the wire. This structure helps to explain the resiliency and flexibility of wrought wire. The grains of the solder appear as larger hexagonal crystals in dendrite form, producing the brittle nature of cast metal. The dark layer of grains may be thought of as representing the surface alloying of the wire and solder. The grains here are of a smaller size but are similar in shape to those of the solder.

Stainless Steel.—Figs. 5 and 6 demonstrate a horizontal union between two stainless steel wires by means of silver solder. This specimen was cut from a headgear appliance that had given satisfactory service over a long period. The fibrous grain structure of the wire is unaffected, and the line of connection of the solder to the wire is clean and straight, with little break. Overheating did not occur. The weakening effect of heat upon 18-8 stainless steel metals requires the use of low-fusing silver solder. In such unions there is little actual surface alloying of the wire in solder. The surface grains of the wire act as nuclei around which the crystals of the cooling solder form. This union, made at a relatively low temperature, may be thought of as a mechanical gripping; a similar mechanical gripping is used by tinners in the process of brazing or sweating copper and brass joints with lead solder. In contrast, the union of gold alloy wire and solder in Fig. 4 resulted in an actual surface fusion.

Unions of stainless steel material made with silver solder should encompass a larger surface area of contact for added strength. At the same time, the

fibrous nature of the grains in the wrought wire may be contrasted to the crystalline dendrite nature of the solder.
Fig. 4.—The soldered joint shown in Fig. 3 at a magnification of ×400 (reduced ⅔).

wire should receive as little soldering heat as possible. When gold alloy solder and wire are used, the minimum of soldered surface is desirable. A more detailed analysis of soldering follows later.

Fig. 5.

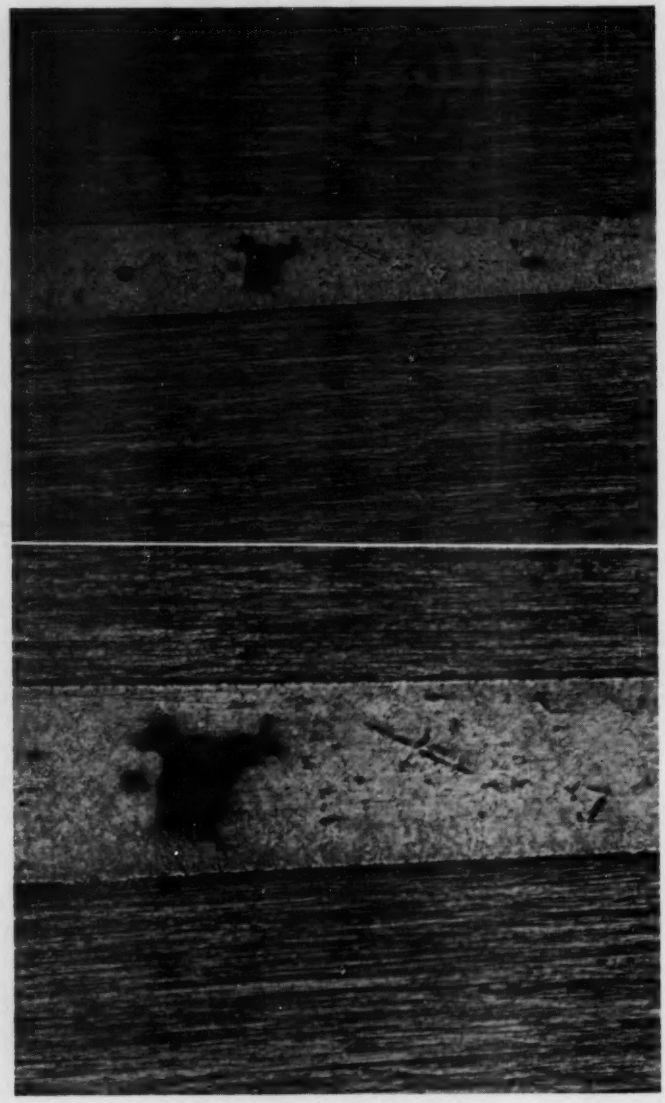


Fig. 6.

Fig. 5.—A satisfactory joint of two horizontal stainless steel wires with low-fusing silver solder. There is no intermediary fusion, but rather a mechanical type union at the surface. (Magnification, ×100; reduced ¼.)

Fig. 6.—The soldered joint shown in Fig. 5 at a magnification of ×200 (reduced ¼).

Figs. 7 and 8 reveal two stainless steel wires soldered with silver solder. The soldered joint here exhibits some of the less desirable characteristics. The numerous dark, circular areas scattered about in the solder may be gas inclusions, the result of impurities that were not entirely removed by the reducing action of the flux. The marked grain growth of the vertical wire

indicates that the temperature was carried into the recrystallization range of the wire. This results in a weakening and a reduction of elasticity. This union would be more satisfactory if the wire retained its original fibrous structure.

Fig. 7.

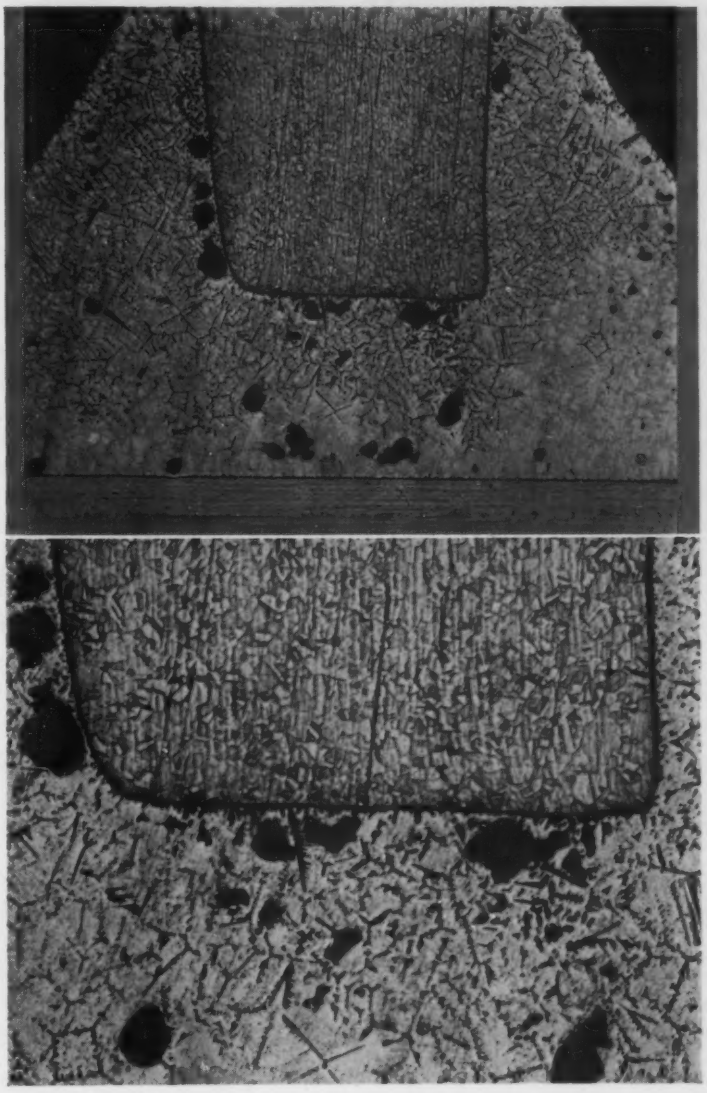


Fig. 8.

Fig. 7.—Two stainless steel wires soldered in a T joint. Overheating has produced excessive grain growth in the vertical wire. The strong fibrous grain structure has been replaced by a brittle cast-metal structure. (Magnification, ×100; reduced ¼.)

Fig. 8.—The soldered joint shown in Fig. 7 at a higher magnification of ×200 (reduced ¼).

A gold alloy staple soldered to a gold alloy band is shown in Fig. 9. The etching reagent did not bring the grain structure of the staple into relief, but the dendrite nature of the solder is visible. A small amount of the staple has been dissolved in the solder to produce a satisfactory weld.

Before sectioning, the gold alloy bracket appeared to the naked eye to be well joined to the band (Fig. 10). Inspection with a magnifying glass showed

Fig. 9.

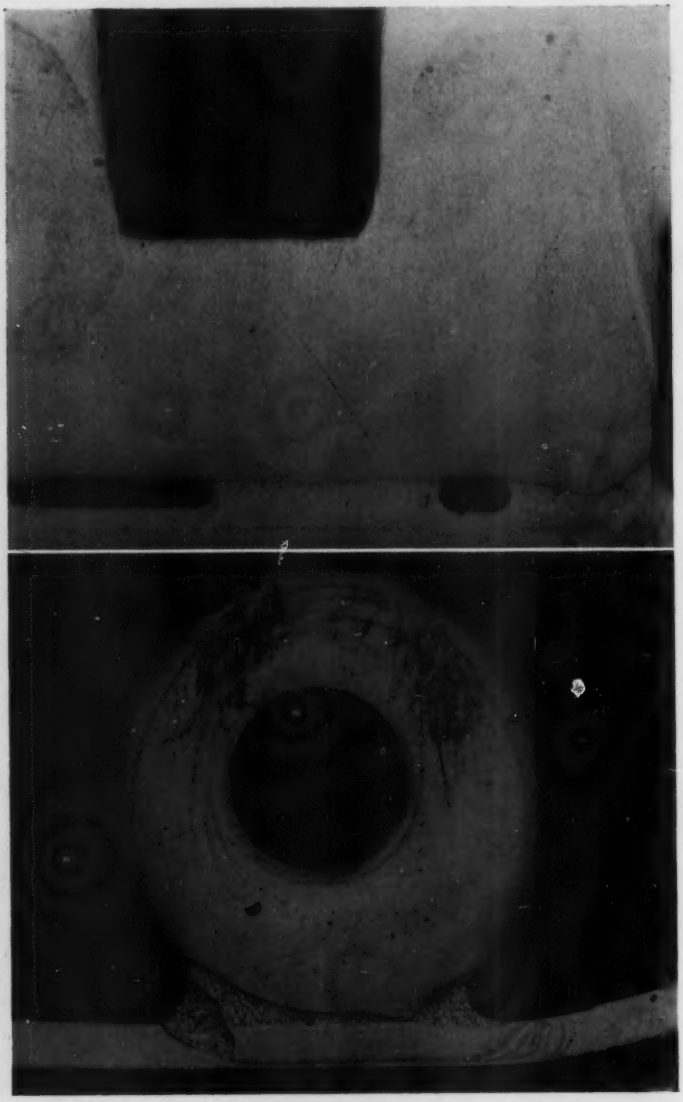


Fig. 10.

Fig. 9.—A gold alloy bracket soldered to a gold alloy band revealing large voids in the joint area. (Magnification, ×100; reduced ¼.)

Fig. 10.—A gold alloy staple soldered to a gold alloy band satisfactorily. There is a slight solution of the staple and some grain growth in the band. (Magnification, ×100; reduced ¼.)

a fine edge of solder around the bracket. Yet, upon sectioning and photographing, it was found that large spaces were present throughout the joint. This lack of complete union may have been caused by debris or contamination on the band or bracket.

Soldering Precautions.—One of the most common causes of breakage of bands and arch wires appears to be overheating. Other causes are overworking, debris on parts, improper fluxing, incorrect use of flame, fatigue, nicking, and inherent structural defects in the metal itself, such as gas and oxide inclusions, voids, cracks, pitting, and porosities.

Overheating: There is a common tendency to keep parts to be soldered in the flame of the Bunsen burner long after sufficient fusion has occurred. Reheating a second time to make doubly sure of fusion is unwise. The strongest joint results from a minimum amount of heat necessary to fuse the solder.

Proper use of the Bunsen burner or blowpipe will help prevent the tendency to overheat. The flame of the Bunsen burner may be described as consisting of three parts. The inner cone contains a mixture of unburned gas and air; this is the coldest part of the flame and will oxidize hot metal. The middle cone, pale blue, is the reducing or deoxidizing flame and contains highly heated gases which combine with limited oxygen. This middle part of the flame should be used for soldering, as it will reduce any oxides that have been formed on the solder or parts to be joined and it is the area of greatest heat. The outer cone of dark purple is the area where incompletely burned gases absorb oxygen from the surrounding air. To attempt to solder in the outer cone or above it will cause oxides to form on the solder and parts, requiring additional fluxing and heating. The amount of air and gas that enters the burner must be carefully controlled. Too much air will produce a flame of reduced heat and incomplete combustion.[3]

Solder may be drawn to any desired direction, including vertical; at a high temperature the surface tension of molten solder is reduced, and it will flow in the direction of increased heat. Solder will not flow easily across a gap because of capillary action. Therefore, as close a proximity as possible of parts to be joined will facilitate joining.

When solder refuses to flow with the usual amount of heat, one should not intensify the heat. By so doing the base metals in the solder may be oxidized and the remainder will ball up and solidify. One should, rather, check on adequate fluxing, presence of debris, gapping, and flame combustion. In the ideal joint of gold alloy wire and solder, superficial alloying of solder and wire occurs with a minimum amount of solder. Prolonged heating will cause grain growth and a deeper solution of the wire, resulting in a weaker joint. After joining, the parts should be quenched to reduce brittleness.

When soldering stainless steel, one may decrease the heat delivered to the steel wire by applying the low-fusing solder first to an intermediary wire. A wiping motion will then transfer the molten solder to the arch wire. The joint is made just adjacent to the flame, yet sufficient heat for fusion of the solder is maintained by direct contact with the heated intermediary wire. In this manner, the corrosion resistance of the stainless steel wire is preserved.

Oxidizing and reducing fluxes have separate properties and uses. Oxidizing fluxes usually contain potassium chlorate and sodium perborate, compounds that readily give up oxygen. During casting operations, these combine with base metals and form a slag that can be easily removed.

Fig. 11.

Fig. 12.

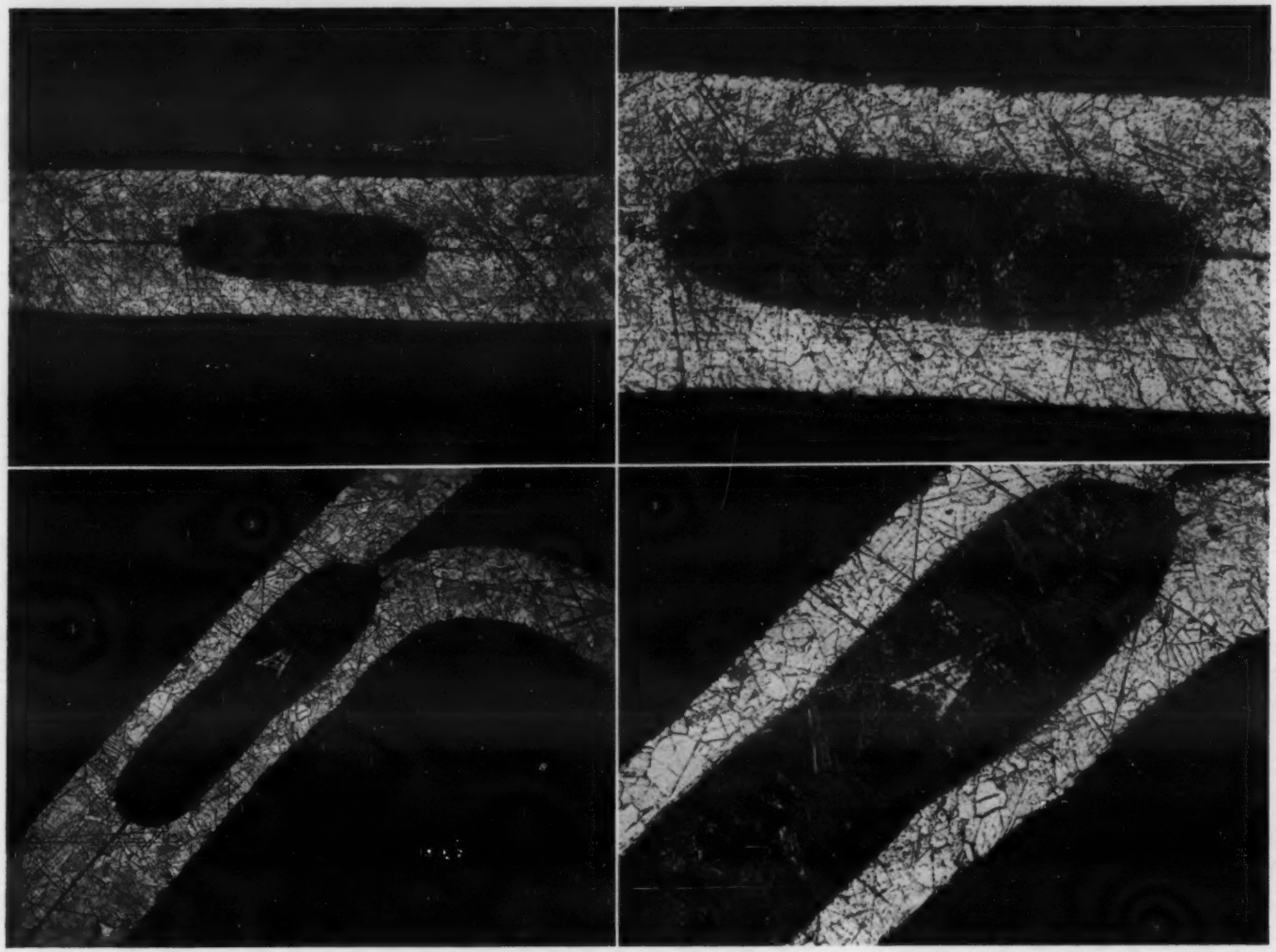


Fig. 13.

Fig. 14.

Fig. 11.—Satisfactory spot-weld of stainless steel band seam. Fusion occurs adjacent to contacting metal surfaces where resistance to current passage is greatest. Surface area remains intact. (Magnification, ×100; reduced ¼.)

Fig. 12.—Spot-weld shown in Fig. 11 at a higher magnification of ×200 (reduced ¼).

Fig. 13.—Satisfactory spot-welds of stainless steel showing recrystallized area of fusion and grain growth in surrounding vicinity where heat was dissipated.

Fig. 14.—Spot-welds shown in Fig. 13 at a higher magnification of ×200 (reduced ¼).

TIGHTLY BOUND

Reducing fluxes may contain borax glass, charcoal, and a petrolatum carrier. The function of a reducing flux is to dissolve metallic oxides and prevent their formation during heating. The molten solder can then slide under the flux and unite with the naked metal. Borax is combined with glass to increase the stickiness and prevent volatilization of flux during heating.

Soldering stainless steel requires a flux capable of dissolving the tough chromium oxide film that gives this metal its noncorrosive character. Such a flux becomes activated at a lower temperature and contains potassium fluoride as the potent ingredient capable of cutting through the chromium oxide film. Other ingredients include borax glass and silica.

Proper fluxing does not alter the necessity of keeping parts scrupulously clean; foreign particles may be difficult to dissolve and necessitate prolonged heat.

SPOT-WELDS

The great increase in the use of chrome alloys in orthodontics during the past twenty years has been due largely to the development of spot-welding as an accurate and reliable method of joining.

Spot-welding or resistance welding consists of clamping two or more sheets of metal between two copper welding tips and joining. The joint or weld is made when a current of high amperage passes through the resistance of adjacent metal surfaces, creating extreme heat. A tiny area of liquefaction is produced. Rapid cooling and solidifying follow, the heat being dissipated in the wide surrounding area.[4]

Figs. 11, 12, 13, and 14 of an 18-8 stainless steel band seam demonstrate satisfactory welds. The recrystallized area is confined to one-half the thickness of the metal. The surface area is unmarred; some grain growth has occurred outside the weld area.

Figs. 15 and 16 demonstrate unsatisfactory welds. Overheating and overwelding have resulted in marked recrystallization, grain growth, and grain distortion throughout the entire weld area. The adjacent areas also have suffered. Such are the effects of superimposing weld upon weld. The surface area is uneven. Corrosion resistance of the seam has been markedly reduced, if not completely destroyed. The seam is weak, discolored, and less able to withstand the constant stresses during lengthy tooth movement.

Figs. 17 and 18 exhibit the effect of poor contact between electrodes and parts. A spark gap was created and produced intense heat which resulted in a squirting out of the hot metal, creating a void, the darkened area at the right. Often, in haste, one presses the contact before bringing both electrodes and parts firmly into apposition.

The character of the weld will be determined by the electrode tip, pressure, time, current, and nature of the metal to be welded. Stainless steel (18 per cent chromium, 8 per cent nickel) is covered by a film of chromium oxide offering heavy resistance to the current and therefore ideally lends itself to welding. The amount of pressure between electrodes must be sufficient to bring the adjacent parts in contact. If a space exists between layers, a spark gap is created.

ing vicinity where heat was dissipated.
Fig. 14.—Spot-welds shown in Fig. 13 at a higher magnification of ×200 (reduced ¼).

Fig. 15.

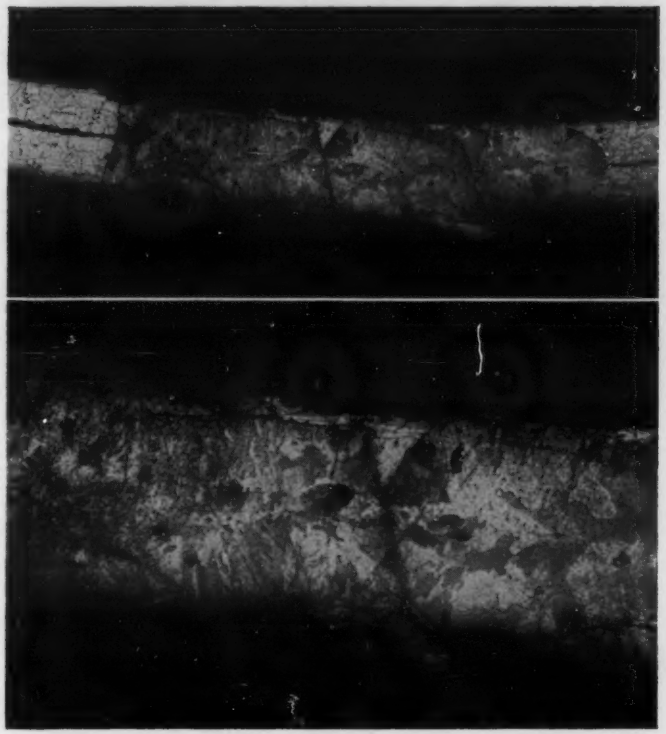


Fig. 16.

Fig. 17.

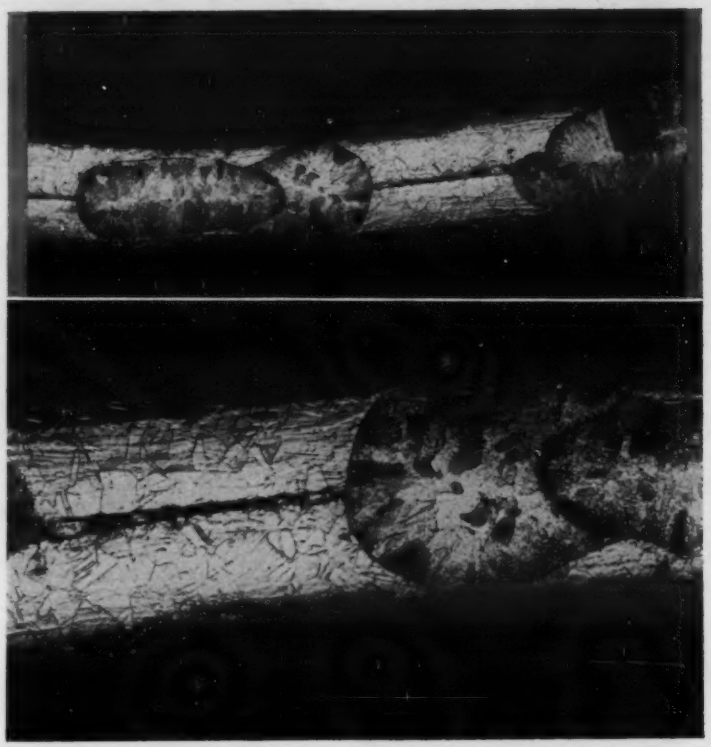


Fig. 18.

Fig. 15.—Unsatisfactory spot-welds due to oversaturation of heat. There is excessive recrystallization of the entire weld area. The surface is irregular and discolored. (Magnification, ×100; reduced ¼.)

Fig. 16.—Unsatisfactory spot-welds shown in Fig. 15 at a higher magnification of ×200 (reduced ¼).

Fig. 17.—Another unsatisfactory saturated weld area is revealed, in addition to a void at the right caused by a poor contact. A spark gap and squirting out of hot metal resulted. (Magnification, ×100; reduced ¼.)

Fig. 18.—The same area shown in Fig. 17 at a higher magnification of ×200 (reduced ¼).

The extreme ease of spot-welding has led to the common tendency to overweld and overheat seams. The average band seam normally requires three individual welds of low intensity for more than adequate strength to resist parting and twisting. A few additional spots add no advantage. An excessive number of spots severely weaken the band. Fusion through one-half the thickness of the laps will result in a strong union. Some original grain structure will then remain above and below the weld to add strength.

Holes, burned areas, surface markings, and discolorations can be kept at a minimum by correct adjustment of current and pressure according to manufacturer's instructions. Frequent careful resurfacing of the copper electrode tips will remove oxidized metal and maintain correct diameter and edge for precise welding.

PHYSICAL PROPERTIES

Elasticity, Slippage.—When an arch wire is slightly bent with the finger, it springs back to its original position when released. One may say that the applied stress has been within the elastic limit of that wire. In a wire under strain one may imagine the atoms in the crystal slightly pushed from their original rest position but still retaining their original pattern and able to snap back if released. The shearing movement of atom against atom is described as slip and occurs along slip planes. Pushed far beyond their normal position by an overpowering force, the atoms fail to recover and a plastic deformation has occurred. Such deformation takes place in the process of rolling, drawing, and forging of metal.[5]

The physical effect of a pliered right-angle bend or deformation upon a wire produces the following changes: In the vicinity of the outer half of the angle stretching has occurred and in the inner half shortening has taken place. The outer portion has resisted the elongation with a tensile stress; the inner portion has resisted the shortening with a compressive stress. Consider this phenomenon set in motion by one bend; then consider the internal structural confusion that must occur in an arch wire in the mouth under the strain of daily mastication, headgear wearing, and wiggling. Excessive plier bending in a confined area produces a similar overworking. A brittling of the wire occurs as a result of grain distortion. There is an increasing inability of the grains to slide past each other. Small cracks appear, and finally the wire is strain-hardened to the fracture point.

When the metal is shaped as in band formation, it becomes work-hardened. Many men purposely pass a curved plier over the buccal edge of the molar band to work-harden it prior to seating. How does this hardening effect the grain structure? It may be explained in this manner: As the layers of atoms are forced to slip by each other, their regular spacing is lost and more resistance to further slipping is offered. One may imagine a pile of oranges squeezed into many irregular shapes that will not slide by one another. The band has become stronger but less plastic. Stresses have developed among the atoms. If cold-working is carried to extremes, brittleness sets in.

Annealing.—The process of annealing or heat-softening releases the stresses produced during cold-working. The atoms relax into their more stable and regular position. Slippage once more becomes easy. In the factory drawing of orthodontic gold alloy wrought wire, one may observe frequent annealing while the wire is reduced from 0.5 inch round stock to 0.01 of an inch diameter. Depending somewhat upon the composition and supplied state, wrought-gold alloy wires may be annealed by heating to 1,300° F. and quenching.[6]

Stainless steel orthodontic metals may not be annealed. Such a high prolonged heat would cause precipitation of the chromium carbides and a simultaneous loss of resistance to corrosion. The heated wire would lose the surface protection of its chromium-oxide film.

During the process of heat-hardening or tempering, the increase in stiffness may be produced by a rearrangement of atoms to new positions of greater resistance to slippage and by a precipitation of new particles at the grain boundaries. (Imagine sand thrown into grease between two revolving disks.) Many gold alloy wires may be hardened by heating to approximately 900° F. and allowing to cool to 450° F. in fifteen minutes. In an excellent paper, Backofen and Gales[7] have shown that 18-18 orthodontic stainless steel wire may safely be tempered with appreciable improvement by heating to 750° F. for ten minutes.

Careful heat treatment is often desirable after an arch wire is completely formed. Its ability to withstand mouth stresses is increased, and often when it is removed after months of activity the original shape is largely retained.

PREPARATION OF SPECIMENS

A step-by-step description of specimen preparation follows to provide the reader with the necessary information should he desire to examine, in a similar manner, some of his own bench technique. Further detailed material may be obtained in Kehl's *Principles of Metallographic Laboratory Practice.*[8]

Briefly, the preparation consists of cutting a small section of metal from the area of breakage and investing it in Lucite. The Lucite cylinder serves to hold the metal firmly and provide a convenient means for handling during the various steps of grinding, polishing, etching, and photographing.

1. *Cutting a Specimen.*—A sample section of wire or band is cut from the joint breakage area or any other area by means of water-immersed stones or disks. Two important precautions should be taken to avoid overheating and dragging of the metal: the use of a slowly revolving wet wheel and light pressure. Otherwise, the surface grains may be altered by overheating, and a true picture of structure might not be obtained. Often, for comparison, a specimen from an adjacent satisfactory area is prepared simultaneously.

2. *Mounting the Specimen.*—Hard thermal plastics such as Lucite or Bakelite are used to form a matrix around the specimen. A metal ring or cylinder similar to that used in inlay investment holds the Lucite and specimen

while the curing process takes place in a mold under heat and pressure. Fig. 19 shows three mounted specimens. The Lucite will adhere to the specimen in close contact and will not be affected by the etching reagent. It will also maintain its flatness during polishing.

3. *Grinding and Polishing.*—The rough grinding stage exposes the correct level of inspection. It is accomplished by the use of files and course-grit emery paper. Intermediate grinding is done by drawing the specimen back and forth over fine-grit emery paper placed on a hard, level surface such as plate glass. One starts with No. 0 and proceeds through the finer grades to 0000 grit. With each successive grit, the direction of the stroke is made at right angles to the preceding one. Fine polishing is done on a cloth-covered revolving wheel. The polishing agent used is a water suspension of alundum powder. This operation removes the fine longitudinal scratches introduced by the last fine emery paper. The final polishing procedure, using a suspension of alumina, removes the previous scratches. The surface should now be

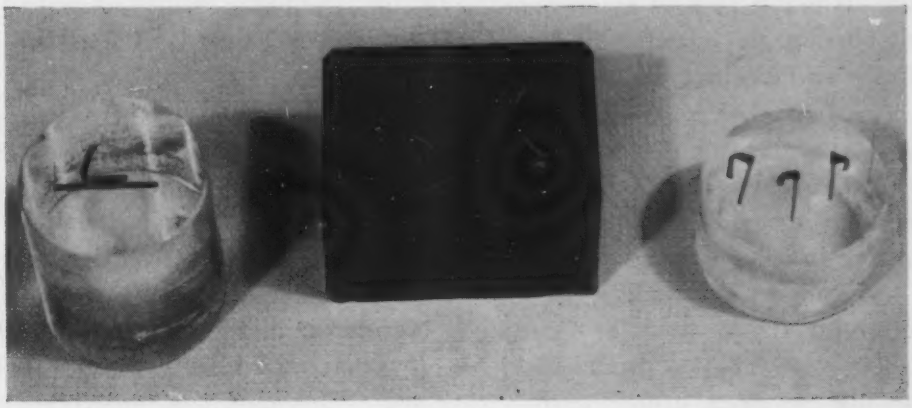


Fig. 19.—Three specimen mounts, including two in Lucite and one in Bakelite. The hard plastic acts as a matrix to facilitate polishing and photography. (Actual size.)

relatively scratch-free when examined under the microscope at a magnification of ×100. If considerable scratches are still present, the last polishing operation may be repeated. The entire polishing operation should require approximately twenty minutes.

4. *Etching.*—The polished surface before etching reveals no grain structure. This is probably caused by an amorphous layer developed in the cold-working during polishing. The surface has undergone plastic deformation by the action of fine abrasive particles. When the etching reagent is applied, the grain structure is revealed by a process of selective dissolving. Differently located and oriented grains have different rates of solution in the etching reagent. The grain boundaries also have different rates of solution. Certain structures are placed in relief, appear bright, and have luster. Other structures appear dark because of shadowy effects and produce an optical contrast. In addition, products of the reagent may be more heavily deposited on some of the grain structures.

Etching reagents are usually dilute solutions of acids or alkalies. The common precious metal reagent is potassium cyanide-ammonium persulfate solution. Marble's reagent is usually used for the 18-8 stainless steel.[8] The actual etching procedure consists of lightly wiping the specimen with a tuft of cotton saturated with the reagent. The surface of the specimen becomes dull in a few seconds, indicating that a reaction has occurred. Etching is halted by immersing in warm running water. A rinse in ethyl alcohol removes any spots and hastens drying. The specimen is examined microscopically for any necessary further etching. Microphotographs are made with a metallograph, an instrument that permits microscopic examination and microscopic photographs of varied magnifications.

SUMMARY AND CONCLUSION

The purpose of this article was to point out some of the differences in grain structure and physical properties between wrought metal and cast metal. It is felt that an understanding of the actual microscopic changes that occur during the construction of arch wires and bands will increase the accuracy and efficiency of mechanotherapy.

The field of experimental metallurgy holds much interest for our profession. A very recent discovery regarding what makes metals weak or strong was made accidentally in a well-known laboratory testing unexplained short circuits in electrical telephone equipment. It was found that a zinc-plated mounting bracket was developing tiny whiskers of tin. Investigation showed the whiskers to be single crystals of essentially perfect structure and of a strength far greater than for the same metal in any other known form. Similar whiskers were produced artificially. Here was an opportunity to test a theory regarding the structure of perfect crystals.[9] This clue has uncovered new frontiers that have excited metallurgists everywhere. With the development of new materials, the orthodontist too may look forward to even further refinements in his armamentarium.

The writer wishes to express his respect and affection to the man who first interested him in this field and more recently was helpful in the preparation of this paper. Richard L. Coleman combines the qualities of scientific investigator, teacher, and humorist. He was formerly a research associate in the Bureau of Standards, Washington, D. C., and is presently research director of the Ney Company in Hartford, Connecticut. The writer also thanks Mr. Adelbert Coe, research associate in the Ney Company, for his assistance.

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SOME CONSIDERATIONS CONCERNING THE PLANNING AND LIMITATIONS OF RETENTION

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The professional man has no right to be other than a continuous student.—*G. V. Black*

INTRODUCTION

IT SHOULD be the objective of every orthodontist to make a continuous study of treatment procedures and to examine and re-evaluate such procedures constantly, seeking the best possible methods of treating each of his patients in order to produce the most satisfactory and stable result. Further, it should be the determination of every orthodontist to make a continuous study of the stability of his finished treatment results, to follow his cases clinically as long as possible, and to evaluate honestly the reasons for success or failure of each case. Achievement of the most satisfactory and stable treatment results will come about only if the approach to the problem of retention of cases and the events occurring in the years to follow is made with an inquiring, scientific attitude. Any discussion among orthodontists is certain to reveal a wide variety of techniques for treating different types of cases, yet all must admit that the problems of the retention period and evaluation of stability of finished results quickly put them on common ground.

It seems only logical that the success of orthodontic treatment should be judged not only upon satisfactory completion of appliance therapy, but upon the events occurring during the retention period and the years following as well. Strang[1] has very concisely defined a successful treatment result as "one in which the objectives of treatment are attained and subsequently remain stabilized thereafter for an unlimited number of years."

It will be the purpose of this article to discuss and present some essential considerations for thought and practical application concerning the problems of retention planning and retention limitations. While most orthodontists are very much aware of the problems of retention, it has been my observation that this subject has been generally overlooked, until recent years, both in the literature and in clinical study. Let us see why this has come about.

This thesis, which was given as a partial fulfillment of the requirements for certification by the American Board of Orthodontics, is being published with the consent and the recommendation of the Board, but it should be understood that it does not necessarily represent or express the opinion of the Board.

Since the earliest days of modern orthodontics,[2] which began in 1900, our specialty has been continuously occupied with its efforts to create and develop the most efficient and convenient techniques for accomplishing tooth arrangement. It has been only natural that development of mechanisms and active treatment procedures, along with problems of case analysis, should have come first to the minds of those who were instrumental in guiding the growth of our young specialty. Ironically, it now seems that many years may have been spent innocently in working in reverse on an approach to treatment procedures while emphasis should have been placed, first of all, upon finding the reasons for stability of untreated and treated cases and then planning appliances and procedures accordingly. Tweed[3] and Nance[4] deserve much of the credit for first approaching the problems of retention and stability from this aspect. Due to rapid progress during recent years in providing increased knowledge and efficiency of active therapy for our patients, it now seems that the time has been reached for all orthodontists to take an increasingly broader viewpoint of clinical orthodontics and finally include retention planning and the years that follow retention in all thought of their treatment planning and consider it the major problem of clinical management.

Englert[5] has written an excellent article recently, in which he notes that in the past there has been little evidence of any willingness or interest on the part of the great majority of orthodontists to follow up on their clinical cases. It seems desirable, then, since our profession is based upon science and facts, that we make a constructive self-appraisal and quiz ourselves as to what happens in the mouths and faces of our patients in the years following dismissal from our practices. What are we actually accomplishing for our patients? Accurate and complete records seem to me to be the first requirement for intelligent appraisal of treatment accomplishment.

The assemblage of data for case stability appraisal should include the following:

1. Complete dental health history of the patient.
2. Dental history of the parents and grandparents, including observation of the parents' mouths, if possible.
3. Cephalometric lateral head x-ray pictures.
4. Intraoral dental x-ray pictures.
5. Oriented full-front and profile photographs.
6. Excellent, well-finished models, obtained in such manner as to show tissue details labially, buccally, and lingually to the fullest extent possible.

Much of the above is routine in most offices for diagnosis. All of the above, however, except for the first two items, should be obtained before and after active treatment with follow-up records and models taken at appropriate intervals of considerable time after all retaining appliances have been discontinued.

DISCUSSION

As mentioned previously, attainment of the greatest possible measure of success and efficiency in case analysis, treatment planning, and appliance therapy has, for many years, occupied the foremost position in the minds of clinical orthodontists. Until recent years, meager knowledge concerning the factors governing the stability of treated and untreated cases has been available; consequently, less has been recorded in the literature on the subject of retention than on any other major phase of orthodontic care.

Probably retention offers a greater multitude of obvious and obscure questions than any other problem encountered through the years. One of the earliest students of orthodontics to become aware of this was Edward H. Angle,[6] in 1907, as he wrote: "It is far easier to lay down rules for governing of tooth movements than for retention. In this field great patience is desired and ample opportunity is offered for originality and skill in technique." Case,[7] Hawley,[8] and Angle[6] devised most of the early retention procedures and appliances, many being in use today in either their original or modified forms. Strang,[9] Kesling,[10] Sved,[11] and Tweed[12] have presented the most notable recent contributions to modern clinical retention therapy. Retention has been investigated extensively through the years from both a biologic and a physical viewpoint, yet appraisal of our treatment results during the following mechanical regulation indicates that there seems to be abundant opportunity for further investigation in this field.

In years past, failure of treatment was based upon the inefficiency of either the operator or the appliance. Usually the operator was believed to fail because of inability to manipulate the appliance at hand in a satisfactory manner. Under the influence of Angle, it was firmly believed that if normal occlusion of the full complement of teeth was established by orthodontic means, the new relationship would be maintained permanently by normal function. The error in this thinking became apparent as soon as orthodontists faced the fact that an alarming percentage of their cases were what could be regarded total failures and sometimes worse. In an effort to reach a solution to the problem, which actually consisted of retention planning requirements and retention limitations about which no knowledge was available, it was noted that many cases treated to what was believed to be normal occlusion, maintaining the full complement of teeth in ideal occlusal relationships, invariably created or maintained a highly objectionable protrusive appearance in both arches. This was obvious, of course, in both the denture and the face. Calvin Case,[7] one of our earliest investigators, made the observation that there seemed to be a discrepancy in a number of cases between tooth material and supporting bone. Later investigators[13] revealed that supporting or "basal" bone was not and could not be increased in linear dimension or volume by appliance stimulation, which led, in turn, to extraction procedures and their verification, first advocated on a practical clinical basis by Charles H. Tweed.[15] Removal of dental units, where indicated, solved the first important step toward the

achievement of stabilized treatment results and enabled operators to produce or maintain, as the individual case analysis might indicate, the most harmonious, balanced profile for each patient.[14]

In a recent personal survey of patients coming to my office for treatment, a total of 335 consecutively diagnosed cases were considered. Of the total, diagnosis indicated that 300 required the removal of four premolar teeth, while only thirty-two cases were treatable with nonextraction procedures. The remaining three cases were treated by removal of only the maxillary first premolar teeth. Why, then, have I found it indicated, as have so many others through personal clinical experience, to treat such a high percentage of cases with extraction procedures? The answer to this question lies in the following essential considerations, which I have found to be of prime importance in retention planning. It is well to note here that I use the term *retention planning* and not *treatment planning*. Emphasis has been placed during diagnosis of each case upon retention planning and projected stability of treatment result; therefore, I look upon active treatment as merely a tool designed to carry out the over-all retention plan with the primary objective in mind of affording maximum opportunity for successful retention.

The first of the essential considerations which must be incorporated into the active treatment plan before natural or mechanical retention can be considered is the important principle of nonexpansion of the denture. "The axiom of mandibular canine width"[9] must be adhered to during treatment, if the operator is to be certain that the denture is not expanded beyond the normal labial or buccal limits dictated by the available supporting basal bone. This means, simply, preservation at all costs of the inherent muscular balance of the denture. Since the denture is in a status of balance as it exists in malocclusion, so it must also remain in the identical status of balance with the musculature in its final treatment form. Such factors as pressure habits, for example, have an undesirable or perverted influence upon the muscular balance as it exerts itself upon the denture and it is important that such etiological and contributing factors be eliminated before and during treatment as much as possible.

Second among essential considerations is the importance of obtaining the most balanced and harmonious occlusal relationships of both dentures as a result of mechanotherapy. This includes proper seating of cusps and proper cuspal interdigitation along with achievement of as nearly ideal, symmetrical arch form and individual tooth positions as possible. All rotations should be overcorrected during active treatment. Since premolar teeth very often must be removed to comply with the first essential consideration as previously given, it logically follows that a highly efficient appliance must be selected which possesses the capabilities within itself of enabling the operator, through proper manipulation, to accomplish bodily movement of teeth in closing extraction spaces and in establishing normal axial inclination of all teeth. Parallelism of roots is the responsibility of the operator and is a highly important requirement in the successful completion of extraction procedures.

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The third essential consideration which must be met in successful planning of retention is the correction of excessive overbites and the exaggerated curve of Spee. Usual correction of the anterior-posterior jaw relationship removes the problem of overjet; however, the fact remains that all too often the deep overbite is still with us at the conclusion of treatment. The requirement is made here that the overbite be "overtreated" under Class II mechanics to the point where an end-on incisor relationship exists, thus making allowance for a mild amount of settling to a normal overbite following treatment. Proper elevation of the posterior teeth and depression of the anterior teeth will provide for optimal maintenance of a normal overbite, if that is possible, which will be discussed further under limitations of retention. An additional important requirement to be considered in treating deep overbites is the use of a multiple-banded technique which will afford second molar anchorage.

Finally, the fourth essential consideration to be noted here concerns the existence of the personal equation. Since all orthodontists must treat patients of a wide variety of ages, temperaments, physical conditions, and family backgrounds, good judgment must be the rule in adaptation of treatment objectives to the treatment requirements and prognosis of each patient as an individual. It seems to me, then, that since our patients' dentures are as different in characteristics as their faces, it is the responsibility of each orthodontist first to prepare himself to create and plan the stability of each case to the best of his ability, accepting along the way the limitations all too often forced upon him. Failure or unwillingness on the part of the operator to seek out and master the techniques and procedures required for proper use of an efficient treatment appliance can be the all-important and determining factor in the chain of events leading to success or failure of retention. Competent attention to the responsibilities of each case accepted by the orthodontist for treatment is equally as important as the faithful cooperation demanded by so many of us from the patient.

NATURAL RETENTION

Retention may be considered and classified in two separate phases—natural and mechanical. Assuming the operator has applied the essential considerations of retention planning previously outlined, which predispose to successful retention, the period of actual retention of the case must be undertaken with the knowledge and awareness of the existence of natural advantages and disadvantages found in both the musculature and the denture. It is generally agreed by all experienced orthodontists that a certain settling of the teeth takes place during and following retention to a greater or lesser degree in all cases. The amount of relapse or settling experienced in each case seems to be dependent to some extent upon the environmental and hereditary influences inherent in the musculature and the dentures, which will be considered at this point. Some of the factors to be discussed, such as tooth form and size (including cusp prominence), cannot be changed by the operator or the patient.

Conversely, such natural retentive factors as insufficient tonicity of the labial musculature can, to some degree, be influenced and improved with the patient's cooperation through myofunctional therapy.

In viewing factors of natural retention, it hardly seems necessary to point out the importance of the presence of discrepancies in tooth morphology found in everyday practice and the limitations or advantages they may impose upon the operator. Discrepancies in tooth form and size exert a definite influence upon adjacent individual teeth and their antagonists which must become a factor in planning retention for every case. I have found that I have been more than repaid for the time and effort spent in doing Kesling anatomic set-ups[10] before treatment is begun in cases where tooth morphology discrepancies exist. Cases presented for treatment with teeth exhibiting prominent, well-formed cusps and deep grooves have a natural retention advantage over others presenting shallow grooves among flat, abraded cusps. Limitations of natural retentive factors may be found in the presence of anomalous and malformed teeth, such as peg-shaped lateral incisors, resulting in discrepancies of harmony of tooth material within an individual arch and of the arches to each other. Fractured incisors, teeth modified in form and size by restorative dentistry, and excessive occlusal wear definitely impose further retentive limitations. Influence of one or more of these factors may very often be responsible for existing midline disharmonies, improper interdigitation of buccal cusps, and poor tooth contacts, which do not promote favorable natural retention.

As emphasized previously, the action of the muscles of mastication and the muscles of expression are of paramount importance in maintaining and creating stability of the dentures. It has been my observation that only a small number of the many patients seen for treatment have been endowed by Nature with very active, tight, labial musculature of high tonicity which lends itself favorably to stability of individual tooth positions and the maintenance of antero-posterior relation of the denture. Insufficient muscle tone and action must be considered as a natural retention limitation, and myofunctional therapy should be instituted whenever possible with every effort made to increase natural muscle tone.

The existence of muscular influence upon the deep overbite problem as associated with the amount of freeway space available has been recognized rather recently as a factor of natural retention. Cephalometric lateral head x-ray pictures are an invaluable aid in determining the amount of freeway space present before treatment is started. In the absence of normal freeway space, observed when the mandible is at physiologic rest position, the limitation of retaining the corrected deep overbite becomes readily apparent. It has been my experience that patients presenting for treatment with a deep overbite due primarily to supraclusion of the incisor teeth of both arches, but associated with good vertical growth of the face, and possessing a normal freeway space will have a favorable retention prognosis as far as stability of the correction of the deep overbite is concerned. On the other hand, typical Class II, Division 2 cases, for example, are seen exhibiting insufficient eruption of the buccal or

posterior segments of both arches and marked supraclusion of the maxillary and mandibular incisor teeth. Limitations of retention are definitely imposed upon this type of deep overbite case, which should be recognized before treatment is started, due to insufficient vertical growth of the face and supporting alveolar bone of the dentures associated with muscular and freeway inadequacies. A poor retention prognosis may be made for maintenance of a normal overbite. True, the operator may assure the parent and patient of a satisfactory treatment result in correction of the anteroposterior and individual tooth relationships; however, it has been my experience that the deep overbite will never be fully stabilized even though mechanical retention is instituted over a considerable number of years.

Lack of completely normal vital processes of the patient, including well-calcified alveolar bone and good health of the supporting tissues of the teeth, predisposes to further limitations of natural retention.

Unfortunately, it seems that very few treated cases may be adequately retained without the assistance, to some degree, of mechanical retention. In a few cases, natural retention alone has been sufficient; however, cases requiring extensive rotation alone during active treatment, transposed teeth, spacing of teeth, overbites of varying degrees, and habits associated with muscular perversions have made it necessary to utilize mechanical retention subsequent to treatment in most cases. It should be the objective of every orthodontist to utilize as little in the way of mechanical retention devices as possible to allow the natural aids of retention to exert themselves freely upon the denture. Mechanical retaining appliances should function as an aid to Nature, and nothing more. It may be well to point out here that, contrary to popular belief, retaining appliances do not best perform the function of stabilization of the teeth immediately following active treatment. Even though individual teeth are quite mobile following removal of active appliances, the bony trabeculae of the alveolar processes and the periodontal membrane accomplish rapid recovery in a few days in restabilizing the teeth under the influence of uninhibited function. It seems that the degree of perfection of tooth position as a result of active treatment, in addition to overtreatment of most malpositions of the teeth, can greatly decrease the requirements and length of mechanical retention. The Kesling positioner has been found to be ideally suited for further perfection of tooth positions to aid in placing them in the best-coordinated positions dictated by muscular balance.[16] Very often, as a result of the extensive use of rigid retaining appliances, I have noted that all the inequities present at the end of active treatment have been preserved during the mechanical retention period.

It appears, then, that placement of rigid Hawley type acrylic retaining appliances immediately following active treatment, as has been my practice in the past, has imposed a limitation of retention upon the case by actually postponing the period of tooth-to-tooth readjustment which normally should be allowed to occur immediately after discontinuation of active appliances. It is my opinion that many of the requirements established in the past for rigid

mechanical retention may be eliminated to a great extent by detailed positioning of individual teeth during active treatment and subsequent perfection of occlusal details by use of the Kesling positioner followed by judicious occlusal equilibration. Dr. Cecil Steiner first called to the attention of orthodontists the existence of canines in supraclusion in the finished cases as one of the primary reasons for the relapse and buckling of the lower anterior teeth following removal of retaining appliances. He observed that canine teeth left in supraclusion created cuspal interferences during lateral excursions of the mandible, resulting in a subsequent "squeeze play" on the four lower incisor teeth. Special plans and provisions should be made by the orthodontist during active treatment to be certain that all four canine teeth are properly depressed at least to, or below, the plane of occlusion. I have discovered that these teeth, even though properly depressed during treatment, all too often rapidly erupt toward each other during retention. Freedom of canine function is then inhibited.

Further limitations of retention may be eliminated, especially the relapse and buckling of the lower incisor teeth may be minimized, by judicious occlusal equilibration. Coleman[17] has stated, "To seek refuge in the idea that defects in occlusal balance are self-rectifying in time is to indulge in wishful thinking."

If the operator is not qualified to equilibrate the occlusion properly, it is then considered good practice to consult a nearby periodontist who has received proper training and experience in this field and then refer patients routinely for assistance during the early retention period. Even though every orthodontist of experience realizes that such limitations previously noted as discrepancy in tooth material between maxillary and mandibular incisor teeth will assert themselves even though incisors have been properly positioned, conscientious and detailed care during treatment and retention followed by equilibration of the occlusion will allow the operator to give the patient the very best within our limited field of endeavor.

SUMMARY AND CONCLUSION

1. Four essential considerations concerning the planning of retention have been presented.

2. The clinical follow-up of all cases during the years following retention, including the assemblage of records and models, seems the only logical, scientific method of judging treatment accomplishment.

3. Due to greater knowledge and increased efficiency of active treatment appliances, retention may be planned today with assurance of greater stability of treatment result.

4. A high percentage of all patients presenting for diagnosis indicate requirement of removal of dental units to meet the requirements of stability and proper retention planning.

5. The operator must observe the limitations imposed by both natural and mechanical retentive factors and allow for them in the treatment plan and retention prognosis.

6. The requirements of rigid mechanical retention can be greatly eliminated or at least minimized by achievement of detailed tooth positions during treatment, followed by use of the Kesling positioner and subsequent occlusal equilibration during retention.

7. It is the responsibility of the orthodontist to prepare himself to plan intelligently the stability of each case to the best of his ability, seeking out the most efficient appliance therapy available to carry out the retention plan.

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PSYCHOSOMATICS IN ORTHODONTICS

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WHILE *psychosomatic* is a relatively new term for an old concept in medicine, it has made great strides and exerted a tremendous influence upon medical thinking during the past twenty years. First defined by Felix Deutsch in 1922, it was introduced into this country twelve years later by Flanders Dunbar.[2]

Derived from the words *psyche* (mind and soul or spirit) and *soma* (body), it postulates mind and body as one and inseparable. It reaffirms "that which we have always known but often forget: One Man, indivisible and whole, not Man, part body, part mind, part spirit."[1]

In short, it simply teaches that the bodily state may be influenced by that of the mind, just as the mental state may be influenced by that of the body.

The idea is as old as the healing art itself. In ancient times, witch doctors and medicine men treated their patients' psychic troubles as well as their bodily ailments. Indeed, they did not know that there was any real difference.[2] With their distasteful herbs and powders and mumbo-jumbo rituals of driving out the evil spirits, they cured as many illnesses by releasing emotional blocks through powerful suggestion as they did with their nasty medicines and blood letting.

For more than 3,000 years India's philosophical Yoga system has recognized and taught the integration of body, mind, and spirit.[3] And the teachings of Christianity have always considered the individual as a whole person, as a unity of body and spirit.[4] Certain it is that the Bible abounds with many instances of healing which, in the light of our present knowledge, can be regarded as hypnotic or psychosomatic therapy.[5]

As early as 380 B. C. Aristotle wrote: "Probably all the affections of the soul are associated with the body: anger, gentleness, fear, pity, sorrow and joy, as well as loving and hating, for when they appear the body is also affected."

When Hippocrates, the father of medicine, said, "The affections suffered by the body the soul sees quite well with shut eyes," he was expressing the psychosomatic viewpoint.[6]

As pointed out by Weiss and English,[7] physicians have always known that the emotional life has something to do with illness, but the structural concepts introduced by Virchow in 1858 led to the separation of disease as only a disorder

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of organs and cells. With this separation of diseases into many different ailments came the development of specialists to attend to all these different diseases. And with the specialists came the introduction of instruments of precision, and the mechanization of medicine began. Medicine now contented itself with the study of the organism as a physiologic mechanism, impressed by blood chemistry, electrocardiography, and other methods of investigation, but unimpressed by and, indeed, often holding in contempt the psychologic background of the patient, which was not considered so scientific as the results of laboratory studies. This period may, in truth, be referred to as the "machine age in medicine." It is not to be denied that remarkable developments have occurred during this period of laboratory ascendency, but it also must be admitted that the emotional side of illness has been entirely neglected.

Not until medicine was faced with thousands of patients whose ailments could not be explained by the bacterial theory of disease or accounted for by structural changes did the pendulum swing back toward the subjective psychic factor as a component of disease. The early discoveries of Mesmer and subsequent experiments of Bernheim, Elliotson, Braid, and McDougall in hypnosis,[5] together with the work of Freud in dynamic psychology followed by that of Ferenczi, Adler, Jelliffe, Menninger, Alexander, and others, have been important contributions to the psychosomatic concept.

Especially valuable was the monumental work of Dunbar, who compiled bibliographic material and published it under the title *Emotions and Bodily Changes* (Columbia University Press, New York); this was followed by her *Psychosomatic Diagnosis* in 1943 (Paul B. Hoeber, Inc., New York). In the same year, Weiss and English published the first textbook on the subject—*Psychosomatic Medicine* (W. B. Saunders Company, Philadelphia).

According to Weiss and English,[7] psychosomatic medicine aims at discovering the precise nature of the relationship of the emotions and bodily function. Research in the subject is founded on the confluence of modern physiologic investigation, as developed by laboratory science and animal experimentation and by the discoveries of psychoanalysis, both representing dynamic outgrowths of medicine. These modern streams of thought and investigation are in the process of integration, and the combination gives promise of establishing real progress in medicine. This whole subject has been given a great impetus as a result of World War II. Indeed, it may be said that psychiatry was established on a firm scientific basis in World War I with its shell-shock victims of social withdrawal, psychic collapse, and nonorganic incapacity, and saw a substantial integration into general medicine in World War II with its thousands of psychoneuroses cases.

Between those patients who are obviously psychotic and those who present with organic lesions are a vast number of sick people whose symptoms have no demonstrable causative basis. These comprise about one-third of all those who seek medical advice, and represent the major concern of psychosomatic medicine. Patients presenting with physical lesions (another third in number) have, in part, an emotional factor. While patients in the remaining group, generally

considered "wholly within the realm of physical disease, which has to do with the vegetative nervous system, such as asthma, migraine, and essential hypertension," are psychically suspect.

PSYCHOSOMATIC DYNAMICS

Ryan[8] briefly summarizes the psychodynamics of psychosomatic medicine from the writings of Dunbar as follows:

1. Bodily changes may be brought about by mental stimuli—by emotions—just as effectively as by bacteria and toxins, and physiologic changes accompanying emotions may disturb the function of any organ in the body.

2. An organ of which the fluid medium is disturbed, and in which perhaps also the blood supply (and thus nutrition) is disturbed, is thereby rendered more susceptible to injury by an additional noxious agent that may be present. More and more, we are learning the importance of thinking that an illness is produced by a particular constellation of factors rather than by a single (monocausal) factor.

3. Inadequate expression or solution of emotion or emotional conflict is particularly likely to occur when the emotion is not a response to what appears to be a real and external situation or danger. An imagined attack is of more potential psychosomatic danger than is a real attack.

4. If action is inappropriate to the actual situation or inadequate to the solution of the confronting problem, the emotion, with its physiologic accompaniments, is likely to be inadequately discharged and so disturb the equilibrium of the organism concerned.

5. If an emotion or an impulse cannot be expressed because of some limitation provided by the environment or the patient's own inhibitions or misconceptions, a conflict is set up and the emotion, or the conflict itself, tends to be excluded from consciousness. Conflicts excluded from consciousness create a permanent tension which may occasion persistent or recurrent disturbances of organic function.

6. If the personality is unable to cope with the problem, if any marked degree of unpleasantness or conflict is involved, the whole process is likely to be excluded from consciousness and thus create a kind of short circuit in the subcortical (hypothalamic) mechanism.

To summarize psychosomatic dynamics further, we use the formula of Weiss and English:[9]

> Psychological disturbance → Functional impairment → Cellular disease → Structural alteration.

RELATIONSHIP TO ORTHODONTICS

Orthodontic thinking, in line with the current tendency of allied fields of science, is undergoing significant orientation. A perusal of dental literature indicates that the growth and ever-widening influence of the psychosomatic concept of the wholeness of the individual is opening up new vistas of approach to the solution of orthodontic problems. There is a more acute awareness of the psychic factor in dental disease and the part that dentofacial abnormalities play in personality disorders and behavior patterns.

Burstone[10] cited ample proof for psychosomatic relations in dentistry and urged that we make every effort to gain knowledge necessary to understand the relationship between the psychic and somatic processes in dental health and disease. Pelzman[13] found that, on the basis of available evidence, it is fair to

say that in the oral cavity the psychosomatic chain of events—emotional conflict, concomitant alteration of physiology, and reversible and irreversible pathologic changes—takes place as frequently as in other parts of the body.

Miller and Firestone[12] defined psychosomatic dentistry as the relationship of mental well-being to the health and integrity of the oral tissues and they enumerated three aspects of it. They are: (1) those cases in which emotional tension causes oral disease through disturbed physiology, as by causing bruxism and chemical changes in the saliva; (2) those in which an oral deformity or dental fear causes an emotional disturbance; and (3) intermediate cases in which there are reciprocal relations between the two.

Landa[13] supported the psyche and soma interrelationship in oral disorders. Ryan[14] stated that the patient and his disease, and his reactiveness to treatment, can never be evaluated with intelligence unless we see the person as the sum of his genetic, familial, and environmental background, and stressed that we have been so emphatic about the physical health value of dental treatment that we have ignored the psychic aspects of the dental experience.

Weiss and English[9] emphasize that the fact that orthodontic patients are children is no reason to believe that they are not subject to emotional stresses in varying degrees the same as adults. Indeed, these juveniles are going through the most critical emotional period of their lives as they approach or enter adolescence with its sudden increase of endocrine activity, the tension of adjusting their sexual and social anxieties, their conflict with parental authority, and religious and ethical concepts.

Ash[15] pointed out that orthodontics deals with patients going through a particularly stressful period of their lives with the added burden of a physical deformity which may give rise to emotional disturbances. He recommended that orthodontic diagnosis include an evaluation of the emotional make-up of the patient and possible psychosomatic influences which might be a factor, and lamented that "... present-day history and questioning charts and methods show little or no evidence of attempts to make such an evaluation. The orthodontist will ask at what age the patient had mumps, but is not interested in the social development. He will inquire as to the birth weight, but fails to investigate characteristics of introversion or extroversion. If psychosomatic factors can have an etiological bearing and influence treatment of other medical and dental conditions, why do they not do likewise in orthodontics? The point to be made here is that they can influence orthodontic treatment. . . ."

Thus, we see that the idea of the integration of mind and body, with their inseparableness allowing for the interplay of influence one upon the other, is enlarging the narrow mechanistic focus of orthodontics to a panoramic view of the whole problem. Far-reaching in its ramifications and effects, it considers (1) emotional conflict as a possible factor in the etiology of dental disease, (2) the reaction of tissue anomalies upon the personality structure and mental well-being of the patient, and (3) the interpersonal relationship of orthodontist and patient and office personnel, due to the psychic motivation in behavior.

The latter part (3) is comprehensive and of wide scope. It deals with (a) the daily tensions built up by psychic and bodily stress upon the personality structure of the orthodontist; (b) its effect upon his health, happiness, and general well-being; (c) its influence upon his attitude toward the patient, which could mean the difference between success or failure in patient cooperation and management; (d) the successful interpersonal relationship of the orthodontist and office staff; and finally (e) the adjustment of the patient to the psychic experience of orthodontic treatment. For the purpose of brevity, we shall consider only the first two parts of the subject.

PSYCHIC DISTURBANCE → SOMATIC ALTERATION

The psychodynamic mechanism which illustrates the above formula operates via the hypothalamus through the autonomic nervous system. Such knowledge is of great importance to orthodontics, since anything which can disturb the health and function and cause structural alteration of the dental tissues strikes at the very core of successful treatment.

As pointed out by Ryan,[16] it is well known that emotions mobilize the bodily forces for overt action, for "fight or flight." If these feelings cannot be expressed in direct action, if they are repressed, they set up tension states that may have dire physical results on the organism. Chronic tension may be expressed in any tissue. The dental tissues, being peculiarly constructed, are especially vulnerable because repair (natural) is not favorable; for example, caries and paradentosis.

Briggs,[17] and Mellars and Herms[18] noted psychogenic factors in dental caries. Glaser,[19] and Henry and Ebeling[19] showed that calcium levels are altered during emotional states. Miller[20] called attention to the tendency of persons under emotional tension to ingest excessive amounts of candy, cake, carbonated beverages, coffee, etc.

Campbell[21] reported: "Experimental observations have demonstrated that the pH, the viscosity of saliva, and to some extent the mineral constituents, may be altered under the influence of fear, rage, and pleasure. Calcium and other ionized salts of the body fluids are affected by emotional states as are the white and red cell counts of the blood. Excessive occlusal stress leads mechanically to paradentosis. Faulty mouth habits have been repeatedly demonstrated to be the expression of attitudes such as repressed rage or fearful dependency. Emotional attitudes leading to inappropriate food habits can lead to chemogenic sources of dental caries, as when the excessive use of refined carbohydrates produces a florid acidophilus culture. Hypocalcemia and osteoclasis can result not only from attitudes involving incorrect food selection but from direct disturbances of the hypothalamus by anxiety despite an adequate intake of calcium."

Stolzenberg[22] found that defective carbohydrates or basal metabolism and endocrine disorders underlie the systemic background of periodontosis. Various sources agree that carbohydrate metabolism can be affected by psychic stimuli. Thyroid and pituitary endocrinopathy have also been associated with periodontal disease. From a psychosomatic standpoint, hyper- and hypofunction of the

adrenal cortex are important factors in the etiology of periodontosis since studies have shown that the adrenals are perhaps the most important part of the endocrine system influenced by emotional disorders.

While Mellars and Herms[23] showed examples of comparatively brief general glandular reactions to shock, anger, fear, and sorrow, they also observed long-term emotional processes due to chronic tension, to worry, anxiety, apprehension, or insecurity, or to a feeling of inadequacy— processes or phenomena occupying cycles of months or even years. It is to such a group of syndromes that they attach significance as establishing irreversible injurious changes in oral tissues.

The role of neuromuscular pressure habits in the etiology of malocclusion is well known. Sorrin[24] has listed thirty-nine habits which may be founded on emotional tension. Salzmann[25] said that it is logical to assume that where local conditions favor changes in the supporting bones of the teeth, the pressure caused by the thumb, fingers, tongue, or lip will produce changes of a malocclusal nature. Massler and Malone[26] found that nail biting is most severe during adolescence, and may become fixated and aggravated by parental condemnation. The act may also become intensified by environmental stresses as well as emotional insecurity, fear, or hate. Rittenberg[27] said that nail biting has long been considered an evidence of a deep-seated disease of the personality. The somatic manifestations are found in the fingers and in the mouth. Again, he said that in every case of bruxism there is a defect in the measures which the personality employs to inhibit aggression. The somatic destruction is the avenue of expression for the psychopathology.

Thus it is that we find many investigators studying the interrelationship of biochemical changes and emotions who attribute emotional conflict as a possible component factor in the etiology of dental caries, periodontosis and malocclusion.

SOMATIC ALTERATION → PSYCHIC DISTURBANCE

Weiss[28] declared that somatopsychic aspects of the dental problem, such as irregular position of teeth, may have considerable influence on the personality of the patient. Farber[29] urged early treatment to restore normal muscular function and development of a pleasing facial appearance to avoid the psychic maladjustment that is almost inevitable in the adolescent with a severe malocclusion. Salzmann[30] said that our attention must be centered on the child as a whole, and not merely on the malformation we undertake to treat, that we are dealing with more than a local somatic problem requiring mechanical force to effect desired dentofacial change, and that we realize also that there are psychic involvements.

Ewen,[31] speaking of the anxieties stemming from dentofacial deformities, said that the social stigma which produced tremendous feelings of insecurity prevent adequate ego formation in these patients. If correction of these defects is possible at an early age, future emotional disturbances may be prevented.

Patients with severe malocclusions frequently experience a very definite psychologic trauma—upheavals and stresses of pronounced magnitude. In a woman, this may represent a personal tragedy, a definite, real, and unalterable

lack of something which cannot be disguised by cosmetics, beauty treatments, or costly clothes. In both men and women, not only pride is affected, but also their confidence, courage, sense of well-being, and their happiness. They know what an important economic and social factor the face is. Sometimes I wonder if we do not become so immersed in the treatment of the teeth and jaws that we fail to realize that in treating them we are treating the whole organism—both body and mind.[32]

We could quote voluminously from the works of psychiatrists, psychologists, social workers, and orthodontists concerning the somatopsychic aspects of dentofacial deformities. For brevity's sake, suffice it to say that it is almost axiomatic that patients present for orthodontic treatment because of a displeasing appearance, whether it be mildly dental or grossly dentofacial. The mother recognizes the handicap and wants to insure her child's happiness and give him every advantage in life's competitive battle. This reflects the importance of the dentofacial apparatus in the public's thinking.

"Because it is displayed at every personal contact with other fellow humans, the face is at once the most significant, the most conspicuous part of the body. It is our façade, the front we present to the world; and from it our fellow human beings form their first impressions before having an opportunity to know anything else of us. Writers have said that upon it is implanted the image of our soul. And, certainly it is true that it is the face which is our most important instrument in portraying our personality to others. Upon it is registered the whole gamut of human emotions. It symbolizes the sum total of personality.

"In the mad rush of this modern age of keen competition, our patients are accepted at their 'face value.' Their faces are their introduction and by it they are judged. Before they get a chance to reveal the charm of their personality, the brilliance of their intellect, or the nobility of their character, their face has prejudiced the world either for or against them. The face has been aptly described as the show window of the mind and body."[32]

THE BODY IMAGE

Having seen the psychologic importance of the face in human affairs, it is only natural that dentofacial deformities, which are so obvious and so constantly exposed to society, constitute an ever-present source of suffering, varying in degree from embarrassment to exceedingly great mental anguish. They are a definite factor in many neuroses. In order to understand better this somatopsychic factor, we shall consider the concept of the body image formulated by Schilder. According to this idea, each one of us carries about a mental image of his own appearance. Normally, this image is a pleasing one. When it is not personally pleasing, the individual is more or less ill from a psychiatric point of view.

The body image is based on two sets of factors. First are our actual sensory experiences concerning the body—what we actually see and feel concerning ourselves, and what we perceive of ourselves in the reactions of others.

For example, the child who is teased by his companions because of some disfigurement will necessarily tend to have a different image of himself than the child who is favored with admiration and affection. The perceptual impressions of early childhood are powerful factors in the subsequent psychologic development of the individual. There is a second group of factors which enters into the formation of the body image—psychologic factors which are an outgrowth of personal emotional experiences. The disfigured child who is adored by his mother will tend to develop a more pleasing body image than the comely child who is rejected. The girl who grows up wishing to be a boy and the boy who grows up wishing to be a girl will tend to develop psychologic distortions of the body image in response to wishful thinking.

These complicated psychologic factors are, in the long run, the most important ones in determining the "structure" of the body image. Certainly, we encounter people every day who have achieved happiness in spite of severe physical limitations, and we have seen neurotics whose debased estimate of themselves is strongly out of keeping with their potentialities or actual achievements. Modifications in actual appearance of the body, however, can cause rapid and sometimes far-reaching changes in the body image. And by causing changes in the body image, (orthodontic) improvement in the appearance of the body can be of psychotherapeutic importance.[33]

The following is a pertinent quotation from Schilder:[34] "We should not underrate the importance of actual beauty and ugliness in human life. Beauty can be a promise of complete satisfaction and can lead to this satisfaction. Our own beauty or ugliness will not only figure in the image we get about ourselves, but will also figure in the image others build up about us and which will be taken back again into ourselves. The body image is the result of social life. Beauty and ugliness are certainly not phenomena in the single individual, but are social phenomena of the utmost importance. . . . Our own body image, and the body images of others, their beauty and ugliness, thus become the basis for our sexual and social activities."

Metaphysical and psychologic authorities all agree that the strongest force in human relations is L - O - V - E, and that possession of it insures happiness and well-being, while lack of it can bring emotional illness and misery. All the basic psychologic drives stem from love. All human beings feel the need for:

A. *Affection.* We need to know that we are wanted, that we are loved.

B. *Adequacy.* To feel that we can achieve, accomplish things.

C. *Recognition.* We want people to recognize our achievements. We want to be well thought of; we want others to see the worthwhileness of our endeavors, to recognize us for things we do.[35]

Peculiarly, love starts with the individual. He must learn to love himself. A child burdened with a dentofacial deformity builds within his consciousness an unpleasant and distressing body image of himself, which may modify or

deprive him of his essential psychologic needs for his happiness. He may become obsessed with a sense of inferiority, self-consciousness, and shame, which could alter his personality and behavior pattern and handicap him socially and economically.

The degree and severity of the psychic trauma effected is dependent upon his reactiveness to the reality of the condition as determined by his constitutional make-up, his familial care and training, and his environment. There are four possible reactions: (1) he may become docile and accept the lot of an oversensitive, frustrated "Milquetoast" character; (2) he may become aggressive and take on an attitude of bitterness and resentment against society and become a candidate for juvenile delinquency; (3) he may salve his injured ego by developing a mechanism of overcompensation; and (4) the deformed child may replace the suppressed modes of self-expression with alternative ones of equal merit.

Or he might seek out an orthodontist and have the deformity corrected and, by thus gaining a new and more pleasing body image, heal the psychic trauma and release the pent-up psychic energy of joy and satisfaction in self-expression. Essentially, orthodontic treatment is psychosomatic therapy, a treatment for the psyche as well as for the soma.

CONCLUSION

Orthodontics has always been conscious of the psychologic implications of dentofacial deformities, but it has been too preoccupied with diagnostic and treatment problems to give the subject anything but cursory attention.

In the beginning, it was concerned necessarily with the mechanics of tooth movement. Force delivered to the teeth through an infinite variety of appliances of intricate design absorbed its attention. Inevitably, there followed the dilemma of tissue reaction to this applied force, demanding enlightenment and solution. Concomitantly, the role of the growth potential in orthodontic therapy remained to be explored, which led ultimately to the birth of cephalometrics. Thus was ushered in the biologic phase of orthodontics, claiming equal status with mechanics.

Of late, however, there are signs that orthodontists at last are gaining an insight into the larger role which they play in furthering human happiness and well-being. They are beginning to understand that orthodontic therapy involves not only a physical aspect, but a mental and emotional one as well. They are interrupting their intense scrutiny of the teeth and associated parts long enough to glance occasionally at the patient himself. And, to the surprise of some, they are finding that they are not working upon an inanimate case number, but upon a living, emotional being like themselves.

They are commencing to realize that in making a case analysis the end result envisaged must not be restricted to a picture of dental tissues restored to health and normal function with resultant optimal esthetics. It must include also the vision of a happy person released from the misery of a soul-searing dentofacial deformity, with its attendant inhibitions and loss of self-esteem, emboldened to strike out confidently for himself and take his rightful place in society.

In short, the psychosomatic concept that malocclusions can mean maladjustments, leading to unhappy and thwarted lives through feelings of inadequacy, guilt, and frustration due to an inferiority complex, is placing a new emphasis on the human equation in orthodontics. It is giving orthodontists a greater appreciation of the scope, importance, and responsibility of their work, which should lead to a deeper personal satisfaction in their professional lives.

SUMMARY

1. The psychosomatic concept postulates the inseparableness of mind and body; the wholeness of the individual; the idea that the bodily state may be influenced by that of the mind, just as the mental state may be influenced by that of the body.

2. Investigators have shown evidence that the psychosomatic principle, working through the automonic nervous system, can be a factor in dental disease.

3. Psychiatrists maintain that a dentofacial deformity, because it distorts the body image, can cause psychic trauma leading to dysfunction of the personality structure and altered behavior pattern.

4. To recommend that orthodontists adopt the psychosomatic viewpoint is not to urge them to practice psychiatry. Psychosomatics is an adjunct to orthodontic diagnosis and practice, nothing more.

5. Psychosomatic orthodontics is *good* orthodontics because it integrates the trinity of component factors in orthodontic practice: mechanics, physiology, and psychology.

6. Adoption of the psychosomatic viewpoint of the wholeness of the individual, with its emphasis on the human equation, will give orthodontists a deeper understanding and a happier relationship with their patients and a greater personal satisfaction in their professional role of furthering human happiness.

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710 WILSHIRE BLVD.

CUSPID STABILITY

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INTRODUCTION

EVERY clinical orthodontist who has had the opportunity to examine patients out of retention six months or longer has certainly observed varying degrees of relapse in many cases. Further examination of these patients would reveal relapses in the vertical plane, as well as the more frequently noted rotations and broken contacts. Present-day appliance therapy offers us the mechanics to effect marked changes in the occlusal level of the teeth as well as the rotation and torque of individual teeth. Yet, all too often we have been confronted with some hard-to-understand relapses. Two apparently similar cases, treated and retained in a similar manner, often exhibit marked differences in stability after retention.

In an appraisal of my own cases, I have noted the frequency of cuspid relapse, especially supraversion, in both the maxillary and mandibular arches. All the patients presenting cuspids in supraversion have a very limited masticatory pattern, and no lateral excursive movement is possible. Many of these patients had good lateral balance, with no cuspid interference, at the time of retention.

Probably most of these patients had a deep overbite with lateral interference in mastication in the deciduous dentition, indicating a long-standing habit pattern.

Begg[1] states that primitive man had an edge-to-edge bite with all cusps worn flat. He also noted excessive flattening of cusps in the deciduous dentition in primitive man.

Strang[2] has stated that a denture in malocclusion is a denture in muscle balance, and treatment planning must take this into consideration. When the inherent muscular balance is violated in corrective procedures, the stability of the final result is jeopardized.

There are many factors involved in cuspid stability, and it would be very difficult to study and evaluate all of them. The list should include masticatory habit pattern, muscle tone, freeway space, quality of alveolar bone, size and activity of tongue, harmony of tooth pattern, hardness of the enamel, and many others. Some specific factors in orthodontic procedures that influence cuspid

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stability would include amount of lateral expansion, anteroposterior relation of opposing cuspids, age retained, time retained, and degree of perfection in the correction.

The following study is an attempt to compare cuspid arch width at the beginning of treatment, at the time of retention, and six months or more out of retention. It also includes cuspid overbite measurements and cuspid interference in lateral mastication for the same series of cases.

METHOD

Forty-three patients out of retention six months or more were selected for this study. An attempt was made to get as many consecutively treated patients as possible in this group. Neither mixed dentition nor multilated cases were included. The forty-three cases were classified as follows: twenty-three Class I extraction cases, seven Class II extraction cases, and thirteen Class II non-extraction cases. Measurements were made from casts at the start of treatment, at the time of retention, and six months or more out of retention.

Mandibular cuspid arch widths, in millimeters, were measured with the calipers placed on the buccal surfaces of the cuspids.

The overbite relation of the maxillary and mandibular cuspids was also recorded for the three series of casts. This measurement, also in millimeters, represented the distance from the incisal tip of the maxillary cuspid to the incisal tip of the mandibular cuspid in the vertical plane with the casts in occlusal contact.

Cuspid interference in lateral masticatory movement of the mandible was recorded for each patient at the beginning of treatment, at the time of retention, and six months or more out of retention.

FINDINGS

Mandibular Cuspid Arch Width Compared to Original Arch Width.—

1. *Twenty-three Class I extraction cases:* The twenty-three cases in Table I showed an average expansion of 2.43 mm. at the time of retention. The same group showed an average expansion of 1.62 mm. six months or more out of retention.

2. *Seven Class II extraction cases:* The seven Class II extraction cases showed an average expansion of 2.37 mm. at the time of retention. This group showed an average expansion of 1.57 mm. six months or more out of retention.

3. *Thirteen Class II non-extraction cases:* The Class II nonextraction group showed an average expansion of 0.97 mm. at the time of retention and an expansion of 0.71 mm. six months or more out of retention.

Cuspid Overbite.—

1. *Twenty-three Class I extraction cases:* The twenty-three Class I extraction cases in Table IV showed an average cuspid overbite of 6.88 mm. at the start of treatment. The average cuspid overbite at the time of retention was 2.63 mm. Six months or more out of retention, this same group showed an average cuspid overbite of 3.28 mm.

TABLE I. EXPANSION COMPARED TO ORIGINAL MANDIBULAR CUSPID WIDTH IN TWENTY-THREE CLASS I EXTRACTION CASES

AT TIME OF RETENTION (MM.)	SIX MONTHS OR MORE OUT OF RETENTION (MM.)
2.5	2.5
3.5	1.2
2.9	1.2
3.0	3.0
3.4	2.5
4.0	2.0
1.8	1.0
3.2	1.5
3.3	2.0
1.8	1.4
1.1	0.9
2.0	1.0
1.9	1.4
3.5	1.5
0.0	0.0
5.5	4.0
2.0	2.0
0.0	0.0
2.0	1.0
0.6	0.2
2.0	1.0
2.0	2.0
4.0	4.0

TABLE II. EXPANSION COMPARED TO ORIGINAL MANDIBULAR CUSPID WIDTH IN SEVEN CLASS II EXTRACTION CASES

AT TIME OF RETENTION (MM.)	SIX MONTHS OR MORE OUT OF RETENTION (MM.)
2.0	2.0
4.6	2.0
0.0	0.0
1.0	1.0
6.0	4.0
3.0	2.0
0.0	0.0

TABLE III. EXPANSION COMPARED TO ORIGINAL MANDIBULAR CUSPID WIDTH IN THIRTEEN CLASS II NONEXTRACTION CASES

AT TIME OF RETENTION (MM.)	SIX MONTHS OR MORE OUT OF RETENTION (MM.)
0.0	0.0
1.8	1.8
0.4	0.0
2.0	1.0
0.0	0.0
0.0	0.0
2.0	2.0
1.5	1.5
1.0	1.0
2.0	1.0
0.0	0.0
0.0	0.0
2.0	1.0

TABLE IV. CUSPID OVERBITE IN TWENTY-THREE CLASS I EXTRACTION CASES

AT START OF TREATMENT (MM.)	AT TIME OF RETENTION (MM.)	SIX MONTHS OR MORE OUT OF RETENTION (MM.)
8.5	3.5	3.8
5.5	3.5	4.3
6.2	3.0	3.0
4.0	2.0	3.0
6.3	3.0	5.0
4.5	2.0	3.4
2.1	1.5	1.5
4.5	2.0	3.5
4.0	2.0	2.5
6.8	3.0	4.0
5.0	2.0	2.2
2.5	2.0	2.0
5.5	3.0	3.0
2.0	2.0	2.0
6.6	3.0	5.0
2.0	2.0	2.0
5.0	4.0	4.0
1.4	1.2	1.2
4.0	2.5	2.5
3.0	3.0	3.0
4.0	3.5	3.0
8.0	3.6	3.8

2. *Seven Class II extraction cases:* The seven Class II extraction cases in Table V showed an average cuspid overbite of 6.5 mm. at the start of treatment, and an average of 3.28 mm. at the time of retention. This group showed an average of 4.15 mm. of cuspid overbite six months or more out of retention.

TABLE V. CUSPID OVERBITE IN SEVEN CLASS II EXTRACTION CASES

AT START OF TREATMENT (MM.)	AT TIME OF RETENTION (MM.)	SIX MONTHS OR MORE OUT OF RETENTION (MM.)
8.0	3.5	4.5
6.5	3.0	4.5
5.8	3.5	4.5
5.0	3.0	3.5
6.2	3.0	4.5
8.0	4.0	4.5
6.0	3.0	3.0

TABLE VI. CUSPID OVERBITE IN THIRTEEN CLASS II NONEXTRACTION CASES

AT START OF TREATMENT (MM.)	AT TIME OF RETENTION (MM.)	SIX MONTHS OR MORE OUT OF RETENTION (MM.)
6.6	4.0	5.3
7.4	2.8	3.5
4.5	3.0	3.2
8.0	3.0	4.1
6.0	2.0	4.0
3.0	3.0	3.0
6.0	3.5	3.5
9.0	2.5	3.0
6.0	3.0	3.0
9.0	3.0	3.0
9.0	3.0	3.0
3.0	3.0	3.0
4.5	3.5	3.5
6.0	3.0	3.0

3. *Thirteen Class II nonextraction cases:* The thirteen Class II nonextraction cases showed an average cuspid overbite of 6.0 mm. at the start of treatment. At the time of retention, this group of patients showed an average cuspid overbite of 3.02 mm. The same group, six months or more out of retention, showed a cuspid overbite of 3.47 mm.



Fig. 1.—Photographs of extraction case in occlusion and in lateral masticatory movement.

Cuspid Interference in Lateral Masticatory Movement of the Mandible.—

1. *Twenty-three Class I extraction cases:* Seven cases presented no cuspid interference at the start of treatment. Sixteen cases of cuspid interference were corrected at the time of retention and presented no cuspid interference. Eight patients in this sixteen-case group presented some cuspid interference six months or more out of retention.

2. *Seven Class II extraction cases:* This entire group presented cuspid interference in lateral masticatory movement of the mandible. Six of the group were corrected at the time of retention and presented no cuspid interference in lateral mastication. Six months or more out of retention, only two of the seven cases had remained stable with reference to lateral masticatory movement of the mandible.

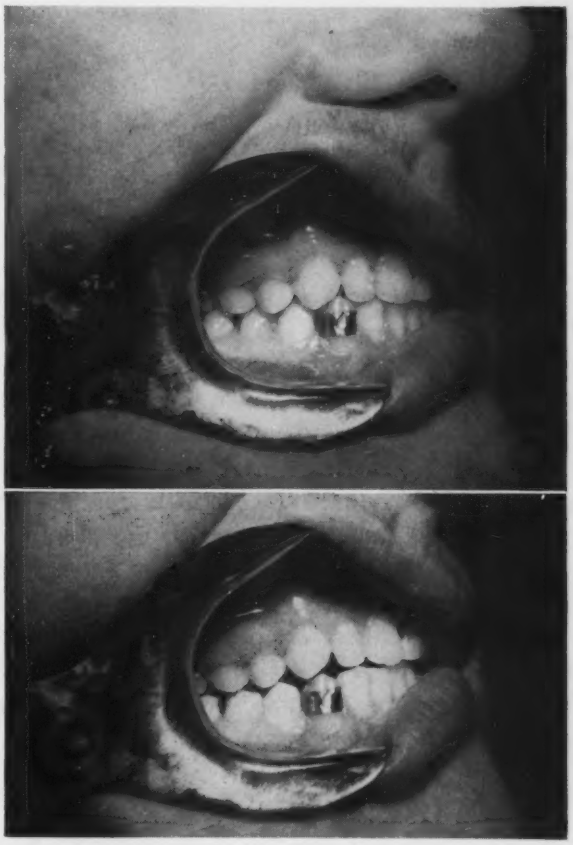


Fig. 2.—Photographs of a nonextraction case in occlusion and in lateral masticatory movement.

3. *Thirteen Class II non-extraction cases:* In this group, two cases presented no cuspid interference in lateral mastication at the start of treatment. The remaining eleven cases were corrected at the time of retention and presented no cuspid interference in lateral masticatory movement of the mandible. Five of the group presented cuspid interference in lateral mastication six months or more out of retention.

RESULTS

Mandibular Cuspid Arch Width as Compared to Original Arch Width.—

1. The entire extraction group showed an average expansion of 2.40 mm. at the time of retention.

2. The extraction group showed an average expansion of 1.59 mm. six months or more out of retention.

3. The non-extraction group showed an average of 0.97 mm. expansion at the time of retention.

4. The nonextraction group showed an average of 0.71 mm. expansion six months or more out of retention.

Cuspid Overbite.—

1. The entire extraction group showed an average cuspid overbite of 6.69 mm. at the start of treatment, 2.95 mm. at the time of retention, and 3.71 mm. six months or more out of retention.

2. The nonextraction group showed an average cuspid overbite of 6.0 mm. at the start of treatment, 3.02 mm. at time of retention, and 3.47 mm. six months or more out of retention.

SUMMARY AND CONCLUSION

Mandibular cuspid arch expansion in successful orthodontic treatment is limited. Most of the patients in this study showed a decrease in cuspid arch width after being out of retention six months or longer.

A comparison of cuspid arch expansion in the extraction and non-extraction groups indicates the possibility of more expansion in the extraction group.

No significant differences in cuspid overbite were noted in comparing the extraction and non-extraction groups. The entire group showed a definite increase in cuspid overbite six months or more out of retention.

Thirty-four of the forty-three patients presented cuspid interference in lateral masticatory movement at the start of treatment. All were corrected at the end of active treatment. Eighteen of this group presented cuspid interference six months or more out of retention.

The present study illustrates the need for more attention to re-education of the masticatory habit patterns of our treated patients.

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1211 PARKWAY.

A STUDY OF THE EFFECTS OF MESIODISTAL REDUCTION OF MANDIBULAR ANTERIOR TEETH

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INTRODUCTION

MESIODISTAL reduction of mandibular anterior teeth is a procedure occasionally used in orthodontics. It is a useful device to gain varying but small amounts of space when the final alignment of the dental units is taking place.

Questions about the technique may arise in the mind of any orthodontist who is conscientiously aware of the future welfare of the teeth involved and who is not just concerned with the expedient solution of the problem at hand. The impact of doubt may be particularly forceful to the men who have had general practice experience and who are practicing orthodontics or to the general dentist whose patients are being treated by an orthodontist, because they are more aware of the fact that the carious process in the mandibular anterior teeth is difficult to solve once it has occurred.

Some of the questions that should be answered are:

1. Does the technique increase the susceptibility of the teeth involved to the carious process?
2. Does the technique materially decrease the resistance of the enamel to the carious process?
3. Is the advantage to be gained worth the calculated risk?
4. If the technique is to be used, what is the proper and logical approach?

A review of the literature reveals only an occasional and casual reference to the technique. Discussions between orthodontists are likely to be confined to the problem of when it may be a useful procedure or whether to leave the contact flat so as better to resist the tendency of the teeth to slip past one another.

It is the purpose of this study to correlate the facts that are known about the tissues and processes involved, and to provide some scientific basis to be used either for or against the technique.

REVIEW OF THE LITERATURE

In one of the few direct references to mesiodistal reduction of mandibular anterior teeth, Lusterman[11] describes the treatment of a Class II, Division 2

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Fig. 2.—Spindles in enamel. (From Orban: Oral Histology and Embryology, The C. V. Mosby Company.)

Fig. 1.—Tufts in enamel. (From Orban: Oral Histology and Embryology, The C. V. Mosby Company.)

malocclusion in which he gained a full 3 mm. by the use of this technique. He states: "Its rationale demonstrates another procedure in technique too readily overlooked by those ephemeral perfectionists who, in their rigid rejection of compromise, too often in reality find themselves straining after gnats." He demonstrates the value of gaining 3 mm. of space in this particular case, but does not give a specific technique.

Ward,[17] in a discussion of periodontal problems, refers to the technique of reducing the mandibular incisal arc. He states: "It is not recalled that there has been caries established due to reduction of tooth width. It must be stated that in all cases, the surfaces must be highly polished."

Heimlich,[7] discussing equilibration which never involves the surfaces under consideration in this study, states: "The relief of interfering surfaces will not make way for caries because the areas involved are self-cleansing."

Since we are using surfaces that are not entirely self-cleansing, we must give attention to the carious process and the enamel which it first must attack. The enamel is designed by Nature to be the protective layer of the anatomic crown of the tooth. It is the hardest substance in the body to resist wear in the highly specialized function of the tooth. Beust[2] indicates that it is composed of 97 per cent inorganic and 3 per cent organic material. The percentages vary somewhat with aging, the more recently erupted enamel exhibiting a higher percentage of organic material—a fact that could have clinical connotations to the orthodontist because, generally speaking, he deals with young enamel.

Orban[13] says that the enamel, microscopically, is composed of enamel rods between which is found a cementing or interprismatic substance. The rods generally are placed at right angles to the surface of the crown, presenting their substance in the most resistant way possible. Also present in the enamel are spindles, tufts, and lamellae, all of which have an important part to play in permeability of enamel.

Scott and Symons[14] state in their textbook that young enamel is equally permeable from the inner dentinal surface and the outer surface. Old enamel, though permeable from the dentinal side, is no longer permeable from the outer surface. Orban[12] indicates that different degrees of permeability could be expected from the outer surface at various age levels and that different degrees of permeability could exist at various levels from the outer surface toward the dentinal surface because of the presence of the organic materials in the lamellae which run all the way from the dentinal surface and gradually become blocked at the outer end (Fig. 3). Enamel tufts arise from the dentinal surface and run up to one-third of the distance toward the outer surface (Fig. 1). Enamel spindles run from the dentinal surface toward the outer surface for short distances and appear to be continuations of some of the dentinal fibers into the enamel substance (Fig. 2). All these structures, together with the organic enamel matrix, contribute to the permeability of the enamel by water, small inorganic ions, and larger ions such as those of dyes.

Gottlieb[5] believes that the decrease of permeability of the enamel with maturity appears to depend in some degree upon unknown characteristics of the saliva and varies with the individual, thereby becoming an important factor in resistance to decay.

Frisbie and Nuckolls[3] state that the carious process involves both inorganic and a proteolytic action.



Fig. 3.—Lamellae in enamel. (From Orban: Oral Histology and Embryology, The C. V. Mosby Company.)

The work of Sullivan[15] in 1954 seems to confirm some of the ideas earlier propounded by Gottlieb and his associates[5] that the carious process can proceed more quickly through enamel by way of organic routes. He states in his summary: "In the deepest parts of the lesions, sequestration of the individual process can be seen, and the earliest sign of the carious process appears to be limited to the substance between the prisms." There is also corroboration here by the work of Frisbie and Nuckolls[3] who, in 1947, concluded that dental

caries is fundamentally a degradation of the organic matrix of the enamel resulting from the enzymatic action of microorganisms, rather than a simple acid decalcification and removal of the inorganic salts.

Gottlieb[4] gives a technique for blocking the invasion routes by deposition of materials in them and indicates that topically applied flourine attracts calcium salts from the saliva, having the same effect of blocking invasion routes.

Wheeler[18] and Orban[12] call attention to the fact that wear of contact points takes place throughout life and results in flattening and sometimes cupping of the enamel (Fig. 7). This process reduces the amount of the enamel available for protection.

No figures could be found on thickness at the contact point.

MATERIALS AND METHODS

The reduction of mesiodistal diameter of mandibular teeth was performed under conditions which would allow accurate observation and measurement of the teeth involved before and after the operation was performed.



Fig. 4.



Fig. 5.

Fig. 4.—Mandibular anterior teeth set up in methyl methacrylate.

Fig. 5.—Stripping of slightly lapped teeth without separation results in contact cut at an angle.

The six mandibular anterior teeth of the same patient were obtained and set up in acrylic resin to simulate positions and firmness of contact found in the mouth (Fig. 4). Mesiodistal diameters of these teeth were measured by means of a metric micrometer to hundredths of a millimeter and recorded.

The contact points were stripped by means of lightning metal strips and cloth finishing strips, the setup of teeth then being taken apart and the mesiodistal diameter again recorded.

Photographs of the work done were made at various steps to illustrate the effects produced on the enamel surface at the contact points.

Thirty mandibular cuspids, thirty mandibular lateral incisors, and thirty mandibular central incisors were obtained and sectioned mesiodistally through the crown to secure figures on enamel thickness at the contact points. Each tooth was measured; the enamel was removed from the mesial contact and

Fig. 6.

Fig. 7.

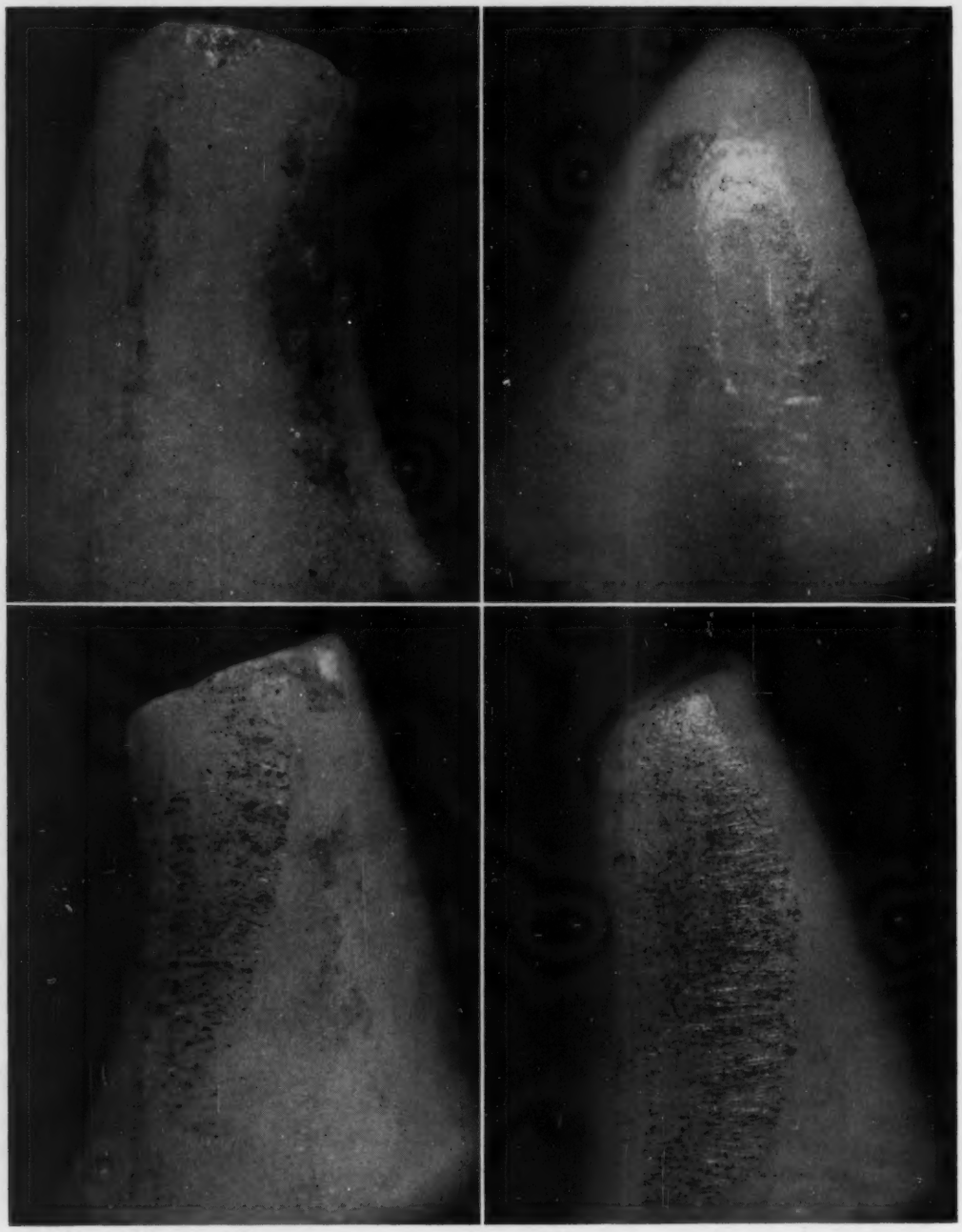


Fig. 8.

Fig. 9.

Fig. 6.—Untouched enamel.
Fig. 7.—Concavity at contact point. Natural wear of approximately 0.10 mm.
Fig. 8.—Contact cut at an angle on lapped tooth with lightning strip—no separation.
Fig. 9.—Contact cut with steel lightning strip.

measured again; and the enamel was removed from the distal contact point, measured again, and recorded. The teeth secured and sectioned were all from adult, racially mixed, Caucasian people.

Materials used for stripping were products of J. Bird Moyer Co.: metal lightning strips (medium and fine) and finishing cloth strips (medium and fine cuttle).

Ferrier and S. S. White separators of appropriate size were used.

OBSERVATONS

After the mandibular teeth were stripped by drawing a lightning steel strip through the contact until the tight contact became free, measurement showed that 0.10 to 0.12 mm. had been removed. This measurement always corresponded to the measured thickness of the strip involved after the abrasive had been worn off to some degree, if a separator was not employed.



Fig. 10.—Contact cut with steel lightning strip and polished with cloth finishing strips.

The surface of enamel, after the metal strip had been used, showed considerable roughness (Fig. 9). When the roughness was smoothed with fine finishing abrasive strips, it was found that another 0.12 mm. had been removed (Fig. 10).

When teeth that were crowded and slightly lapped were stripped, it was found that the contact area tended to be flattened in whatever plane was in contact (Fig. 8).

Considerable care had to be used to maintain a normal rounded contour of tooth surface. Most of the rounding had to be in the polishing of the surface after the contact point was free enough to draw the strip in a curve. If a separator was used, the strip could be controlled much easier.

The thickness of enamel at the contact point of lower anterior teeth from adults is shown in Table I.

TABLE I

TOOTH	AVERAGE			GREATEST			LEAST		
	TOTAL	MESIAL	DISTAL	TOTAL	MESIAL	DISTAL	TOTAL	MESIAL	DISTAL
		(MM.)			(MM.)			(MM.)	
Central incisor	5.00	0.544	0.522	5.88	0.88	0.70	4.40	0.37	0.36
Lateral incisor	5.83	0.650	0.683	6.50	1.05	0.98	4.95	0.47	0.50
Cuspid	6.58	0.763	0.900	8.53	1.11	1.80	5.27	0.38	0.55

DISCUSSION

Mesiodistal diameter reduction of mandibular anterior teeth does increase the hazard to caries by reducing the amount of protective enamel present. The enamel is Nature's protective layer on the tooth, and if it is thinned the protection is lessened by the amount removed. The perspective cited here is probably the least important, provided the amount of enamel removed is restricted to less than one-half of that available. If the patient becomes caries susceptible in the future and the mandibular anterior teeth are attacked, the amount removed would merely delay total penetration for a short period.

The more important points that increase the hazard are as follows:

1. Flattened surfaces that defeat the cleansing action of embrasures.
2. Roughened enamel that would tend to retain debris (Fig. 9).
3. The removal of enough enamel to expose the inner portion that contains numerous tufts and spindles, in the immediate future or in the distant future when enamel wear takes place and more enamel is lost.
4. The failure to take steps to age artificially enamel that is exposed when the semimatured surface enamel is removed.

Mesiodistal reduction of mandibular anterior teeth should be avoided if possible, and perhaps a very slight crowding should be accepted as a nearly universal phenomenon. Emphasis should be placed on alleviating any factors that would bring contrictive pressures on these spaces, such as correcting habits referred to by Atkinson[1] and equilibration[7] when cuspid interdigitation would indicate such a course.

If it is determined that reduction is desirable, then the procedure should be approached with a logical technique. My idea of such an approach would be as follows:

1. Determine the approximate amount of space needed.
2. Determine the maximum amount that can be removed from each tooth contact. The table given on enamel thickness would seem to indicate approximately 0.20 mm. for each central contact, 0.25

mm. for each lateral contact, and 0.30 mm. for each cuspid contact. These figures would give a total possibility for a 3 mm. gain in space.

3. Determine at which points space needed would be most advantageously employed.
4. Protect lips, tongue, and gingiva by placing rubber dam over teeth to be worked on.
5. Place separator in contact to be adjusted and gain enough separation to permit free handling of strip to be used, which should be flexible.
6. Holding strip in the same curve as the proximal of the tooth, draw it through or back and forth until an estimate of the desired amount of tooth structure is removed. Polish surface.
7. Impregnate surface with the Gottlieb technique[4] or the topically applied fluoride technique.[8]
8. Record, for future reference, surfaces worked on and the approximate amount removed.

SUMMARY

The literature pertaining to mesiodistal reduction of mandibular anterior teeth was reviewed and only occasional references to the subject were found.[7, 11, 17]

The latest dental anatomy texts were reviewed to obtain modern findings on enamel substance.[2, 12-14, 18] Enamel spindles and tufts run approximately one-third the distance from the dentinoenamel junction through the enamel, while lamellae run all the way through (Figs. 1, 2, and 3). The matrix of enamel surrounds the enamel rods and prisms and can be considered as extended all the way through the enamel. Spindles, tufts, lamellae, and matrix essentially are organic materials.[12-14]

Enamel matures from childhood eruption until adult life by the organic substance of enamel becoming permeated from the external surface inward with calcium salts from the saliva.[4-6]

The late literature on caries disclosed that the organic material of enamel undoubtedly plays an important part in the carious process, in many instances being the initiating and penetrating factor in the process.[3-6, 15]

The difference between tight contact and loose contact was found to be 0.10 to 0.12 mm. and the difference between tight contact and completely clear contact, 0.23 to 0.25 mm.

In stripping, if a separator was not employed, the amount removed was directly related to the thickness of the strip being used, caused by binding against the next tooth as it was being drawn through.

If less than 0.10 mm. was to be removed or that amount divided between both teeth making contact, it was necessary to use a separator to permit free handling of the strip.

The average thickness of enamel at the contact points in adult mandibular central incisors measured was found to be 0.59 mm., in mandibular lateral incisors, 0.66 mm., and mandibular cuspids, 0.82 mm. No definite correlation was found between tooth size and enamel thickness at the contact points. The largest tooth did not always have the thickest enamel but, generally speaking, the larger teeth had more enamel thickness than the smaller teeth.

A step-by-step technique was given for mesiodistal reduction of mandibular anterior teeth. The roughness of enamel after the use of metal strips was demonstrated (Fig. 9), which points to the necessity of polishing with fine cloth strips in order to leave an acceptable surface.

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651 NORTH CENTRAL AVE.

Editorial

CAUTION AND RADIATION

IF YOU have read the excerpts from a report* entitled "The Biological Effects of Atomic Radiation" made by the National Academy of Sciences and released on June 13, 1956, probably you, along with many others, are bewildered by the observations with regard to medical and dental x-rays being a hazard to human life.

At about the same time, Dr. L. S. Taylor, chief of the National Bureau of Standards' Atomic and Radiation and Physics Division, revealed that world scientists have recommended that the level of exposure to radioactivity be lowered. Dr. Taylor also made the observation that experimentation has now definitely shown that radiation overexposure not only is capable of producing immediate harm to individuals, but that it also may shorten their life span and affect their progeny. Dr. Taylor further said that the nation's 65,000 dentists, along with many other professional persons, are not very well briefed on how much x-raying they can do with safety. In all, most of the stress seems to be placed not on immediate physical symptoms of x-ray exposure but on a speculative intangible effect upon a certain biologic system that is particularly sensitive to radiation.

The report, devoted to the over-all health factors involved in radiation from atomic experiments and other sources, said, "Any amount of radiation, however small, is hazardous from a genetic or hereditary standpoint." The scientists who compiled the report claim that x-rays are being employed too frequently and suggested that physicians cut down on x-rays (except in cases of clear necessity) to head off what could become a menace to procreation and the health and well-being of future generations. Much more interesting, however, is the observation in the report that "the harm is cumulative. The genetic damage done by radiation builds up so it is reported as the radiation is received, and depends on the total accumulated gonad dose received by people from their own conception to the conception of their last child." The study recommends, among other things, that the use of x-rays for persons under 40 be reduced a great deal.

Some dental authorities, when interviewed, quickly described the report as "unfortunate and misleading," pointing out that the report has "caused needless apprehension to hundreds of dental patients" and that many dentists had reported patients calling to cancel appointments for x-ray examinations of their teeth as a result of the public warning.

*U.S. News and World Report, June 22, 1956.

Within late years, many orthodontists have become routine users of the x-ray as a diagnostic aid. Your editor then took it upon himself to interview some well-known x-ray specialists and authorities who have enjoyed wide scientific background and clinical experience. The following are some impressions gleaned as a result of these interviews with those who should know at least a part of the answers to this phase of x-ray, particularly if experience in practice of radiography is any criterion.

1. Dental x-rays were first used in 1895; millions of persons have been x-rayed. There is no record of any physical ill effects of proper x-ray examination (that anyone seems to know anything about). Dental x-ray exposure, properly made with approved modern x-ray apparatus, today has no harmful effects on patients if used according to prescribed methods of procedure. (Exposures are now shorter, according to these x-ray authorities.)

2. These experienced men observe also that there can be little doubt that many persons with insufficient or inadequate training for the job are exposing dental x-ray film, and that there is much room in this area for improvement; even so, there is nothing in the record to cause alarm to the dental patient.

3. Diagnostic head x-ray pictures, they contend, should never be taken over and over during a short interval of time; if taken, the x-rays should be at a reasonable distance from the patient, with ample filters, and exposures should be made at least several months apart. On one important point they *do* agree unanimously: that there is much more physical hazard for the operator than for anyone else, and that burns still do happen occasionally to the careless operator who fails to take proper precautions and who grows careless in utilizing the well-known protective measures so well understood in all x-ray technique.

One expert interviewed seemed to spell it out succinctly when he said, "An x-ray tube is like a loaded gun—don't take it lightly and become careless." There are some other interesting points which they made. A routine dental x-ray may deliver 5 roentgens to the patient's maxilla or mandible but the dosage to the more remote parts of the body, such as the gonads, is obviously scant, but highly speculative in effect.

If the report of the Academy of Sciences is reasonably acceptable, a few points seem certain for the field of the dental and head x-ray: (1) There are a lot of intangibles that plainly nobody knows much about above and beyond the one man's opinion or the speculative level. (2) To take x-ray pictures for esthetic satisfaction or for any other than therapeutic purposes is to speculate the question as to whether the benefit exceeds the intangible disadvantages pinpointed by the report of the National Academy of Sciences and other authorities.

Perhaps it is prudent, nonetheless, for the Academy of Sciences and other experts such as Dr. Taylor to alert all workers who direct captive radiation directed to the human body to the fact that there still are some unknowns in radiation.

One thing is certain: the "finger of caution" has been raised by those who should know and that finger no doubt will be heeded by those who are not so sure that they know all the speculative intangibles that are by-products of the x-ray tube when directed to the human body. Someone someplace has said that to be forewarned is to be forearmed.

H. C. P.

In Memoriam

KENNETH FRANCIS TERWILLIGER

1895-1956

KENNETH F. TERWILLIGER of San Francisco died on May 20, 1956, thus ending a distinguished career in orthodontics. At the time of his passing and during most of his twenty-eight years in the specialty, he was a member of the faculty of the Division of Orthodontics, School of Dentistry, University of California. This long association with the University brought him into contact with several generations of orthodontic students, who remember him as an advocate of the highest possible standards in clinical procedures, and as one who was always available for counsel in the years after graduation.

Although Dr. Terwilliger was highly regarded for his clinical attainments in all phases of orthodontics, his judgment was particularly respected by his colleagues in medicine and dentistry with respect to orthodontic treatment of cleft palate problems. He was a founding member of the cleft palate consultative panel at the University of California and of a similar group at St. Francis Hospital in San Francisco. His last contribution to the orthodontic literature dealt with this difficult problem, and appeared but a few weeks prior to his passing.

Dr. Terwilliger had many worth-while and interesting accomplishments outside his profession. Very much of a sportsman, he was an expert fly fisherman and not only tied his own flies, but fashioned his own fly rods with a skill which commanded the respect of professionals in the field. He was a skilled cabinetmaker and particularly enjoyed the carving of fine woods and the making of furniture of his own design. In earlier years he used to hunt with bow and arrow, using equipment of his own making.

Dr. Terwilliger was a member of Xi Psi Phi, Omicron Kappa Upsilon, the Pacific Coast Society of Orthodontists, and the Edward H. Angle Society of Orthodontia. He was a fellow of the American College of Dentists, and a member of several civic and fraternal organizations in San Francisco.

He is survived by his widow, the former Mary Lena Miller; a daughter, Mary; and two brothers, Theodore S. and Glendon H., an orthodontist of Oakland, California.

W. L. W.

Department of Orthodontic Abstracts and Reviews

Edited by

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Growth Curves of Height and Weight by Age for Boys and Girls, Scaled According to Physical Maturity. By Nancy Bayley, Ph.D., Bethesda, Md. *J. Pediat.* **48**: 187-194, February, 1956.

The growth curves for height and weight are derived from averages at each age of large numbers of children who differ in their physical maturity, that is, in the stage they have reached in their progress toward adult status. For children under 8 or 9 years, this method has little effect on the shape of the growth curve. After this age, however, conventional height-for-age curves are misleading when the growth of an individual child is compared with them.

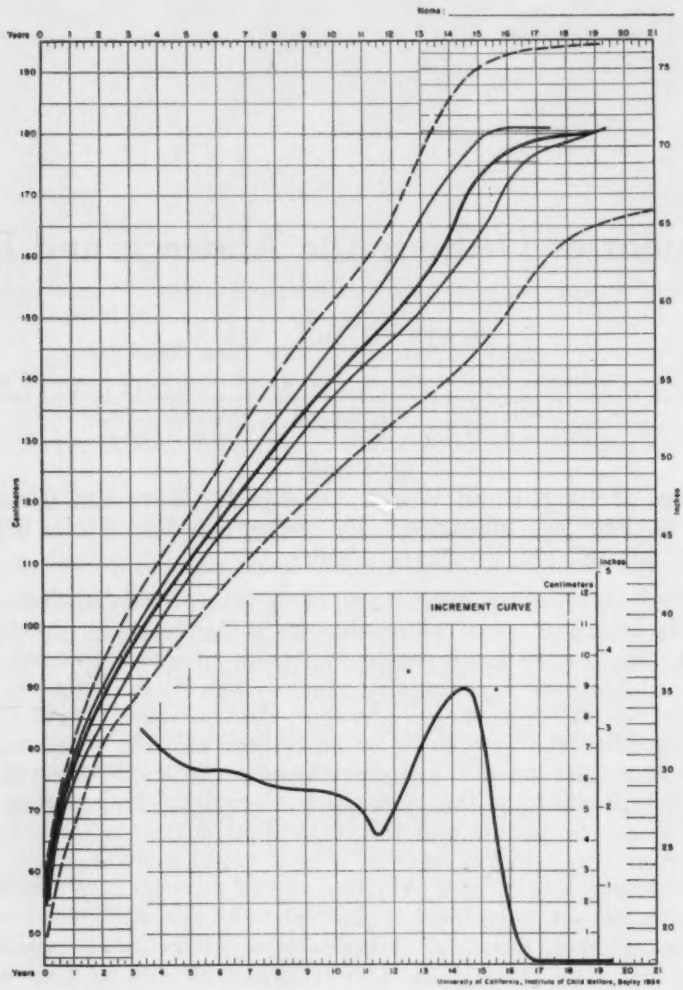
Children normally have a prepubertal spurt of rapid growth, much more rapid than is indicated by the curves of averages. The reason for this discrepancy between the norms and the individual curves is that there is a wide spread among children in the ages at which rapid growth starts. This spurt of growth is closely linked to a child's stage of puberty. We find at 13 years, for example, immature prepubertal children who are still growing moderately at the childhood rates, pubertal children who are growing rapidly, and postpubertal children who already have approached closely to their adult stature. The same may be said, but with different percentages of prepubertal and postpubertal cases, for the 11-year-old children, 14-year-old children, etc. Thus, in comparing any child with the norms, he may appear to lag behind or to spurt ahead in an irregular fashion, when actually, on his own time schedule, he is growing in a perfectly normal way.

The curves in the chart are designed to match the growth rates of normal individual children. They are based on the measurements of about 300 healthy California children, an equal number of each sex, who are measured repeatedly from birth until 18 to 21 years of age. The data have been grouped so that for each curve the measures at any point on the curve represent averages for children who are alike in their physical maturity. Physical maturity was determined by readings of x-rays of the hand and knee and by the per cent attained of each child's own adult stature.

Growth in height (Figs. 1 and 2) is closely related to rates of physical maturing. This is true during adolescence in particular. Children may be as much as three years accelerated or retarded from the average in their rates of maturing. Girls mature faster than boys, on the average. They thus attain their adult height about two years younger than boys, and are also five or six inches shorter as adults.

The heavy central curve represents the growth in height of an average-sized boy (or girl) who is maturing at an average rate.

GROWTH CURVES OF HEIGHT BY AGE : BOYS MATURING AT AVERAGE, ACCELERATED AND RETARDED RATES



BOY

Case Number _____ Birth Date _____

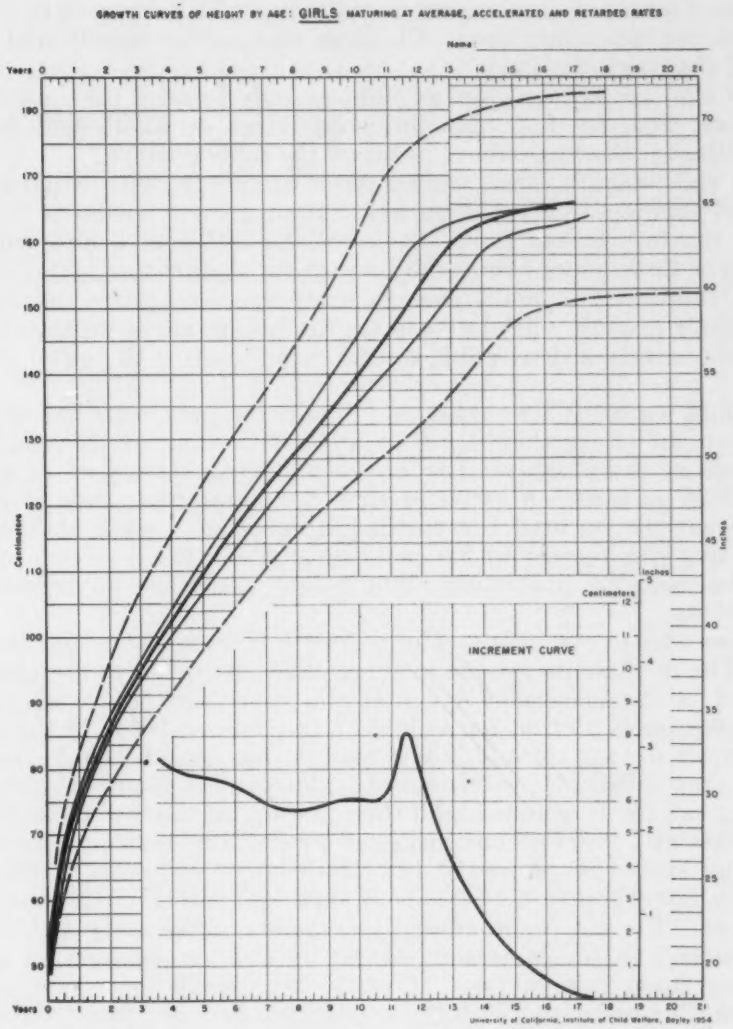
PERCENTS OF MATURE HEIGHT

Age Years	Average	Accel-erated	Retarded
Birth	28.6		
1.0	42.2	44.5	40.4
2.0	49.5	51.3	47.0
3.0	53.8	55.6	51.6
4.0	58.0	60.0	58.0
5.0	61.8	64.0	59.7
6.0	65.2	67.8	63.8
7.0	69.0	70.5	66.8
8.0	72.0	73.5	69.8
9.0	75.0	76.5	73.2
10.0	78.0	79.7	76.4
11.0	81.1	83.4	79.5
12.0	84.2	87.2	82.2
13.0	87.3	91.3	84.6
14.0	91.5	95.8	87.6
15.0	96.1	98.3	91.6
16.0	98.3	99.4	95.7
17.0	99.3	99.9	98.2
17.5		100.0	
18.0	99.8		99.2
18.5	100.0		
19.0			99.8
20.0			100.0

RECORD OF MEASURES

Date	Age Year	Age Month	Stature Inches	Stature Cent.	Annual Gain	Skeletal Rating Age Eq.	Predict. of Adult Height

Fig. 1.



GIRL

PERCENTS OF MATURE HEIGHT

Age Years	Average	Accelerated	Retarded
Birth	30.9		
1.0	44.7	48.0	42.2
2.0	52.8	54.7	50.0
3.0	57.0	60.0	55.0
4.0	61.8	64.9	59.8
5.0	66.2	69.3	63.9
6.0	79.3	73.4	67.8
7.0	74.0	76.0	71.5
8.0	77.5	79.5	74.5
9.0	80.7	83.5	77.7
10.0	84.4	87.9	81.0
11.0	88.4	92.9	84.9
12.0	92.9	96.6	88.2
13.0	96.5	98.2	91.1
14.0	98.3	99.1	95.2
15.0	99.1	99.5	97.8
16.0	99.6	99.9	98.9
16.5		100.0	
17.0	100.0		99.6
18.0			100.0

Case Number _____ Birth Date _____

RECORD OF MEASURES

Date	Age Year	Age Month	Stature Inches	Stature Cent	Annual Gain	Skeletal Rating Age Eq	Predict. of Adult Height

Fig. 2.

Children who are accelerated in maturing will have growth curves more like one of the two upper lines. Children who mature slowly will grow more like one of the two lower lines.

Those who are tall or short as children only because they are fast or slow in maturing, and are not constitutionally large or small, will have growth curves similar to those just above or below the central curve.

Some children are large from a very early age, with a pattern of both accelerated bone age and rapid growth. Their growth is similar to that represented in the top broken line. They will be tall adults, and will gain this height two or three years before the average for their sex.

Some children are small from an early age, and grow and mature very slowly. Their growth will approximate the lowest curve on the chart. They will probably attain a short adult stature, usually after 18 (girls) or 20 (boys) years.

If a child's growth is unusual, and does not approximate one of the central curves, then an effort should be made to determine his physical maturity. Skeletal age of the hand, read from Greulich-Pyle standards, is a good indicator for this purpose. A series of such S. A. readings, made at intervals of about a year, can be used for plotting a curve of growth that will show a child's height with respect to his own "timetable." Such assessments of S. A. can also be used for predicting adult height, from the Bayley-Pinneau prediction tables.

Another way to evaluate a child's growth is from his annual increments in heights. The increments for the average child, maturing at the average rates, are plotted in the increment curve at the bottom of the chart. If a series of heights by age is plotted for a child on the upper portion of the chart, then, from a curve drawn through these points, his height can be read off for each year that is included in his curve. The amount of growth from one year to the next can be determined, and then plotted on the lower chart (e.g., if he was 47 inches at 7 years and 51 inches at 8 years, his increment for that year is 4 inches and should be plotted at the mid-point or 7½ years). His increment curve will show whether his periods of slow and fast growth occur at the expected times. The maximum annual increments of the early and late mature are represented on the increment charts by dots at the ages of greatest increment for these two curves. If early, the child's increment and growth curves should be compared with the accelerated curves; if late, the comparison should be made with the retarded curves. Ordinarily, larger increments in height are found for physically accelerated, and smaller increments for physically retarded, children. The degree of a child's acceleration or retardation will show in the age at which his maximum increment occurs.

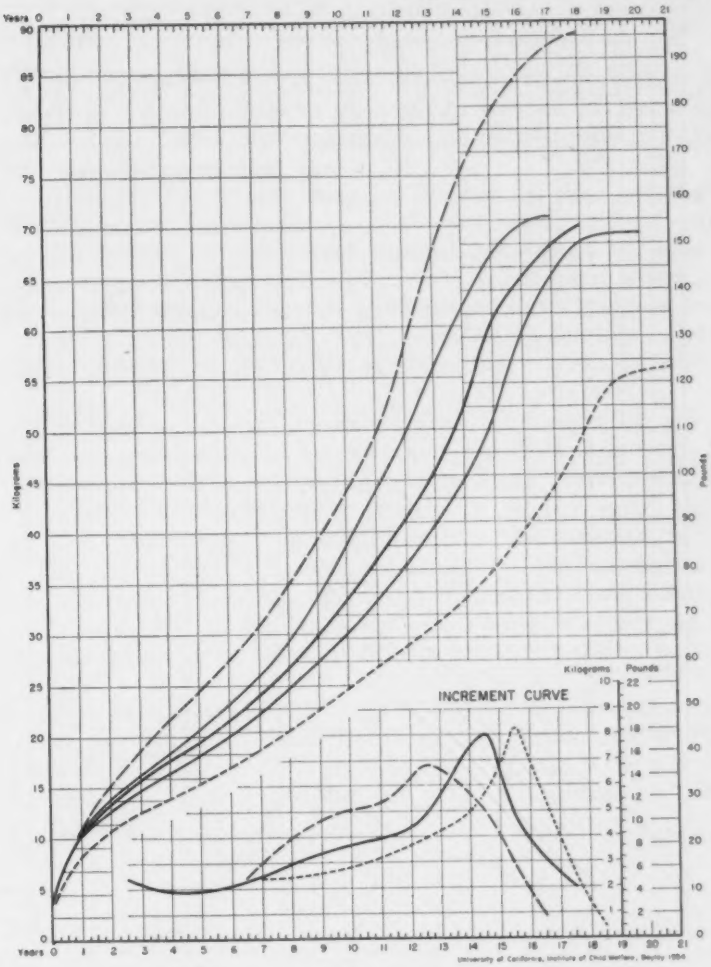
Sometimes the point of inflection on the increment curve occurs sooner or later than would be expected from a child's previous record and skeletal development. Apparently, in such cases the steroid phase of growth is (often normally) accelerated or delayed. When this occurs we find a shift in the pattern of growth. For example, when the spurt is delayed, the childhood growth continues, slowly, and the eventual acceleration starts from a greater stature than if it had occurred sooner. For this reason, such children will turn out to be taller adults than their childhood measures would have indicated. The converse of this condition may be found in the child whose rapid growth starts earlier than expected, and results in shorter-than-expected adult stature

WEIGHT

The weight charts, Fig. 3 for boys and Fig. 4 for girls, have been constructed from data on the same children and in the same groupings used for

GROWTH CURVES OF WEIGHT BY AGE: **BOYS** MATURING AT AVERAGE, ACCELERATED AND RETARDED RATES

Name _____



BOYS

Case Number_____ Birth Date_____

MEAN WEIGHT FOR HEIGHT

Age Years	Average Height Inches	Average Weight Pounds	Accelerated Height Inches	Accelerated Weight Pounds	Retarded Height Inches	Retarded Weight Pounds
Birth	19.8	8.4	–	–	–	–
1.0	30.7	22.9	30.9	23.8	29.3	23.4
2.0	34.6	29.3	35.2	31.1	32.8	27.3
3.0	38.0	34.6	38.6	35.5	36.2	30.6
4.0	40.6	39.0	41.5	41.4	39.6	35.7
5.0	43.7	42.8	44.5	45.9	42.3	40.3
6.0	45.8	47.6	47.2	51.8	44.9	44.1
7.0	48.7	52.9	50.0	56.9	47.0	48.5
8.0	50.9	59.2	52.5	65.0	49.4	54.7
9.0	53.1	66.8	54.9	74.6	51.8	60.2
10.0	55.3	74.1	57.3	86.0	54.1	66.1
11.0	57.5	82.2	59.6	97.2	55.9	73.4
12.0	59.1	91.3	61.8	109.8	57.7	80.7
13.0	61.4	101.4	65.6	124.8	59.4	90.2
14.0	64.6	116.0	68.5	134.5	61.7	100.1
15.0	68.1	133.8	70.7	147.9	64.2	112.2
16.0	70.1	142.6	71.7	154.1	67.7	131.0
17.0	70.5	149.7	71.7	158.9	69.5	143.1
18.0	70.9	154.1	–	–	70.5	150.8
19.0	–	–	–	–	71.3	151.7

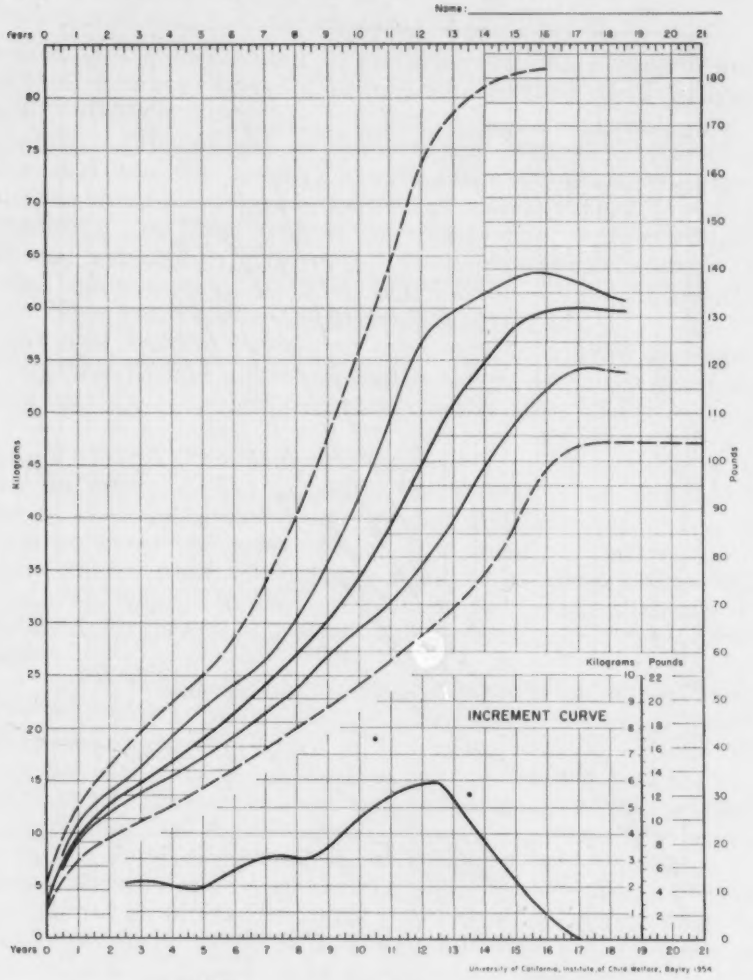
RECORD OF MEASURES

Date	Age Years	Age Months	Weight Pounds	Weight Kilograms	Annual Gain

Fig. 3.

GROWTH CURVES OF WEIGHT BY AGE: **GIRLS** MATURING AT AVERAGE, ACCELERATED AND RETARDED RATES

Name: _____



GIRLS

MEAN WEIGHT FOR HEIGHT

Age Years	Average Height Inches	Average Weight Pounds	Accelerated Height Inches	Accelerated Weight Pounds	Retarded Height Inches	Retarded Weight Pounds
Birth	19.3	7.5	20.1	–	–	–
1.0	29.1	21.5	30.6	24.0	28.3	21.2
2.0	34.4	28.0	34.4	30.2	33.3	25.9
3.0	37.5	32.4	37.8	34.7	36.7	30.6
4.0	40.6	37.5	41.3	42.1	39.4	33.7
5.0	43.1	41.2	44.1	48.1	41.7	37.9
6.0	45.9	46.7	46.9	53.2	44.5	43.0
7.0	48.1	52.9	49.2	57.3	47.2	47.6
8.0	50.4	60.0	52.0	66.8	49.2	51.1
9.0	52.7	66.4	55.1	78.5	51.5	59.7
10.0	55.1	76.1	57.3	92.2	53.3	64.8
11.0	57.5	86.6	60.4	108.9	55.5	69.9
12.0	60.7	99.2	63.1	124.8	57.7	78.0
13.0	63.0	112.4	64.3	131.2	59.8	86.9
14.0	64.2	121.0	64.8	135.0	62.4	99.0
15.0	64.8	128.8	65.0	136.7	63.8	108.5
16.0	65.2	131.6	65.2	139.3	64.5	114.6
17.0	65.3	132.3	65.2	137.6	64.8	119.3
18.0	65.3	131.8	65.2	134.5	64.9	119.0

Case Number _____ Birth Date _____

RECORD OF MEASURES

Date	Age Years	Age Months	Weight Pounds	Weight Kilograms	Annual Gain

Fig. 4.

the height charts. Thus a point on the center curve represents the average weight and average age of children at a given degree of physical maturity. The weights of children who are retarded in physical maturing are found below and to the right of the central curve.

Annual increments for weight may be entered on the lower section of the weight charts, using the same method as described for height. It should be noted that as for height, the greatest annual increment of weight is above average for the early-maturing girls. However, for boys this is not true. The physically accelerated boys appear to have consistently large average weight gains, with no exceptional spurts. The retarded boys remain slender, with small gains in weight, until the sharp increase with puberty occurs at about 15 years.

There is provided a table of mean weights for height by age for each of the three maturity groups. The accelerated children are normally heavier than average for their height, while the retarded are correspondingly slender.

Normally, a child's weight curve should be in the same channel as his height curve, and the two curves should follow the same pattern of annual increments. The extent and direction of disparity in channels for a child's weight and height are indicators of his or her nutritional status. In using these charts, we are able to rule out the deviations that are due to normal variations in degree of maturity and in the child's pattern of maturational rates.

Children tend to put on extra weight during the prepubertal period at about 10 to 12 years. Such fat usually disappears as soon as pubertal maturing and rapid growth in height are well started. The child's weight will then return to the channel that is normal for him as he regains balance in his hormonal functioning.

News and Notes

American Association of Orthodontists

The American Association of Orthodontists will hold its fifty-third annual meeting May 13 through 16, 1957, in New Orleans, Louisiana. Reservations are being handled by the Local Arrangements Committee, of which Dr. Bertney G. Frick, Jr., 1231 Maison Blanche Bldg., is chairman.

American Board of Orthodontics

The next meeting of the American Board of Orthodontics will be held at the Roosevelt Hotel in New Orleans, Louisiana, May 7 through 11, 1957. Orthodontists who desire to be certified by the Board may obtain application blanks from the secretary, Dr. Wendell L. Wylie, University of California, School of Dentistry, San Francisco 22, California.

Applications for acceptance at the New Orleans meeting, leading to stipulation of examination requirement for the following year, must be filed before March 1, 1957. To be eligible, an applicant must have been an active member of the American Association of Orthodontists for at least two years.

Central Section of the American Association of Orthodontists

The Central Section of the American Association of Orthodontists will meet Oct. 1 and 2, 1956, at the Edgewater Beach Hotel in Chicago, Illinois.

Great Lakes Society of Orthodontists

The twenty-seventh annual meeting of the Great Lakes Society of Orthodontists will be held at the Chateau Laurier in Ottawa, Ontario, Canada, Oct. 7 through 10, 1956. The preliminary program follows.

Sunday, Oct. 7, 1956

6:00 P.M. Dinner Get-Together.

Monday, Oct. 8, 1956

8:30 A.M. Breakfast for everyone—President's Address.
10:00 A.M. Holly Halderson: Routine Physiological Tooth Movement.
11:00 A.M. Louis H. Whitehead: Investments and Financial Planning for the Dentist. (Wives welcome to sit in.)
Afternoon. Sightseeing for everyone.
7:00 P.M. President's banquet.

Tuesday, Oct. 9, 1956

9:00 A.M. Gustav Korkhaus: Retarded Development of the Middle Facial Skull and Upper Jaw.
10:00 A.M. W. G. McIntosh: Periodontia.

11:00 A.M. Louis H. Whitehead: Answers to Questions From the Previous Day's Address, Also Continuation of Previous Day's Paper.
2:00 P.M. Scott Holmes: Ethics of Transfer Cases.
2:30 P.M. James Jay: Occipital Anchorage.
3:30 P.M. James Coupland: Oral Surgery.
Business Meeting.
7:00 P.M. Table Clinics.

Wednesday, Oct. 10, 1956

9:00 A.M. Gustav Korkhaus: Experiences With the Norwegian Method of Functional Orthopedia in the Treatment of Distoclusion.
10:00 A.M. T. M. Graber: Thumb- and Finger-Sucking.
11:00 A.M. Richard E. Barnes: Early Treatment.

Wives are invited; entertainment has been arranged for them.

Middle Atlantic Society of Orthodontists

The annual meeting of the Middle Atlantic Society of Orthodontists will be held Oct. 14, 15, and 16, 1956, at Haddon Hall, Atlantic City, New Jersey. T. M. Graber, Chicago, Illinois, B. F. Dewel, Evanston, Illinois, and Harlan Shehan, Jackson, Michigan, will take over the scientific program. Daniel E. Shehan of Baltimore, Maryland, is president.

Northeastern Society of Orthodontists

The fall meeting of the Northeastern Society of Orthodontists will be held in Hartford, Connecticut, Monday and Tuesday, Oct. 29 and 30, 1956, at the Hotel Statler.

Pacific Coast Society of Orthodontists

The Pacific Coast Society of Orthodontists will hold its annual meeting Aug. 13, 14, and 15, 1956, in Seattle, Washington, with headquarters in the Benjamin Franklin Hotel.

Southern Society of Orthodontists

Under the leadership of Dr. William M. Jarrett, president, the thirty-fifth annual meeting of the Southern Society of Orthodontists will be held at the Greenbrier Hotel at White Sulphur Springs, West Virginia, Aug. 19 through 22, 1956.

The committee consists of Drs. Ralph Rudolph, Chairman, Charles Hopkins, Carl A. Laughlin, Hubert E. Martin, Richard K. Steiner, and J. Mark Trach. It is announced that an attendance of 300 is expected. The meeting is being held in midsummer, and at a resort hotel, and elaborate provision is being made for outdoor entertainment in addition to the scientific program.

Southwestern Society of Orthodontists

The Southwestern Society of Orthodontists will meet Oct. 7 to 10, 1956, at the Shamrock-Hilton Hotel in Houston, Texas.

Loan Fund Established in Memory of Dr. Kenneth F. Terwilliger

Prompted by a desire to provide a suitable memorial to Dr. Kenneth F. Terwilliger, his friends intend to establish a loan fund for orthodontic students at the University of California School of Dentistry.

A loan fund gives help when it is most needed; yet the provisions for repayment make it a lasting, growing tribute.

Dr. Terwilliger gave his services as a teacher to his alma mater throughout his professional career, and accepted these duties with a real sense of responsibility. He was always in accord with measures which aided students and at the same time strengthened self-reliance. Thus, we think that he would have approved the plans we now advance, as he would have favored the name we propose for the loan fund: The Edward H. Angle Loan Fund (established in memory of Kenneth F. Terwilliger).

Those who wish to make contributions now or in the future may make checks payable to the Regents of the University of California, and send them to the Chairman of the Division of Orthodontics.

GEORGE W. HAHN
GLENDON H. TERWILLIGER
FREDERICK T. WEST
WENDELL L. WYLIE.

The Teeth of the Stone Age

Should Stone Age man *(Homo Neanderthalensis)* consume a twentieth century diet, his teeth would be subject to the same ills as the teeth of modern man *(Homo Sapiens)*.

After a survey of the microscopic quality of human teeth found in a number of Old and New World settlements dating back to prehistoric times, Dr. Reidar Sognnaes of the Harvard School of Dental Medicine believes that "man has proved too clever for his own good, dentally speaking."

Dr. Sognnaes extends hope, however, that man may, through research directed toward more precise understanding of what constitutes perfectly developed teeth, overcome his cleverness and regain sound dental health.

"Defects in tooth development are exceedingly rare in certain subhuman primates such as the wild rhesus monkey," Dr. Sognnaes observed. "This leads to speculation as to whether or not early man's teeth were of a superior developmental structure."

Dr. Sognnaes' observations on his research are reported in the current issue of *The American Journal of Pathology*. Through courtesies extended by the Peabody Museum of Harvard University, the Anthropological Museum, University of Athens, and the Department of Anatomy, University of Oslo, he obtained specimens of human teeth for measurement and microscopic examination. The specimens originally came from paleolithic Palestine, prehistoric Greece, predynastic Egypt, ancient Iceland, middle age Norway, and from ancient Guatemalan and Pecos Indian (New Mexico) sites in the New World.

The oldest tooth specimens obtained by Dr. Sognnaes, from the Stone Age period in Palestine, showed the formation of poor dentine (ivory tooth tissue) and poor calcification. All Old World teeth show poor calcification, and this seemed to result from disturbances occurring during the early years after birth. The evidence, Dr. Sognnaes believes, is that the deterioration of teeth began at the time of the cave man and was steady over a period of thousands of years. Finally, in the Pecos Indian teeth (A.D. 1100-1700) fifty per cent had cavities. The Pecos Indian teeth, he found, were very prone to faulty microscopic structure.

"The teeth of the Pecos Indian," Dr. Sognnaes observed, "seemed to deteriorate more and more through the period studied. Part of this poor mineralization was probably due to a steady diet of corn, with undernourishment as a contributing factor."

The structure of prehistoric Greek teeth compared to successive samples up to the time of Christ, Dr. Sognnaes found, did not show statistically significant differences. Teeth from the Archaic Classic to the Romaic (eq) period were not materially worse than

the prehistoric period, but were far better than those from contemporary Greece. Although Greek teeth showed developmental defects as far back as 3,000 B.C., an increase appeared only in the course of recent history.

Dr. Sognnaes also notes that "Stone Age teeth could be grouped with those of modern man with respect to the range and severity of developmental defects in the dental microstructure, probably due to inadequate or irregular diet."

"Certainly," he wrote, "the dietary habits of these cave dwellers must have been greatly different from the subhuman primates living in the treetops or roaming in the woods, incapable of using other tools than their own teeth."

One conclusion that might be reached through this analogy, Dr. Sognnaes sets out, "would be to suggest that the primates maintained uniformly perfect tooth structure only as long as they were basking in the sun of the treetops, depending for survival upon the perfection of their teeth; that the terrestrial apes (subhuman anthropoids as the wild chimpanzees, gorillas, gibbons, and orangutangs) tended to have teeth of an intermediary microstructure, less perfect than the monkey but superior to early man; and that early man proved too clever for his own good, dentally speaking, when he entered the cave and in the struggle for life discovered the use of other tools than his own teeth for the capture and preservation of food."

Dr. Sognnaes concludes, hopefully, that all may not be lost to man, dentally speaking.

"It may be," he says, "that civilized man, in order to withstand the impact of the oral environmental conditions prevailing today, will need teeth of developmental qualities superior to those of his ancestors, both from a microstructural and microchemical point of view.

"In future generations it may not only become feasible to prevent the severe microstructural defects in dental development . . . but to incorporate into the teeth the optimal chemical ingredients (as fluorine and other trace mineral factors) in proper amount and ratio to each other."

Dr. Sognnaes is Professor of Oral Pathology at Harvard University and Associate Dean of the Harvard School of Dental Medicine. He is a native of Bergen, Norway.

Notes of Interest

Leonard Frantz, D.D.S., M.S., announces his inactivation from duty with the United States Public Health Service in Washington, D. C., and the opening of his office at the Biscayne Shopping Plaza, 561 Northeast 79th St., Miami 38, Florida.

Ignacio R. Quijada, D.D.S., announces the limiting of his dental practice to orthodontics, 123 E. Marcy St., Suite 3, Santa Fe, New Mexico.

Harold Silverstein, D.D.S., announces the removal of his office to the Professional Building, 280 Mamaroneck Ave., White Plains, New York, practice limited to orthodontics.

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THE AMERICAN JOURNAL OF ORTHODONTICS is the official publication of the American Association of Orthodontists and the following component societies. The editorial board of the AMERICAN JOURNAL OF ORTHODONTICS is composed of a representative of each one of the component societies of the American Association of Orthodontists.

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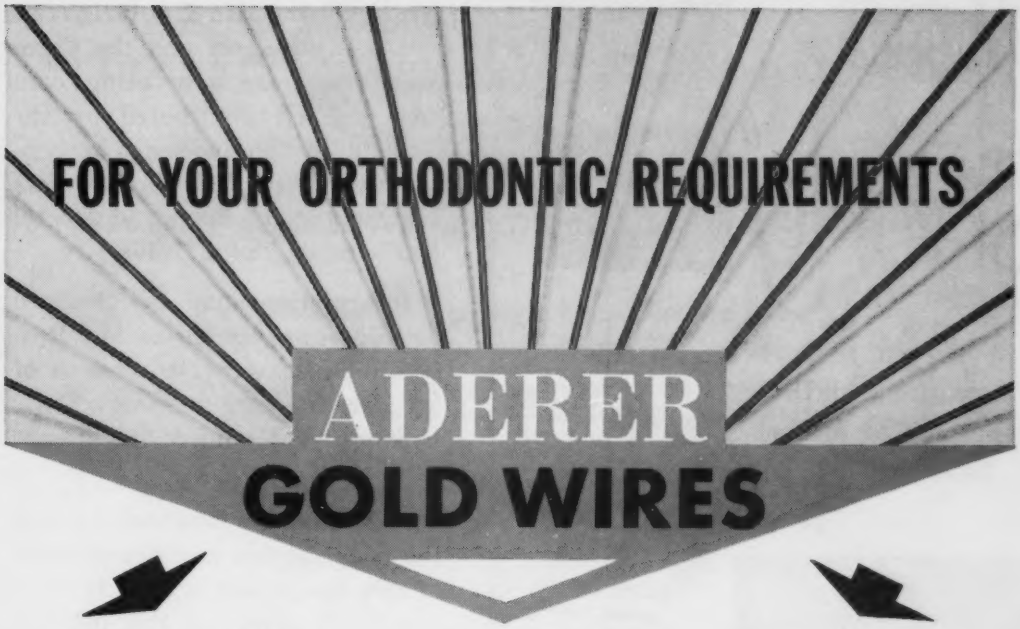
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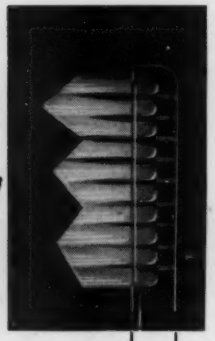
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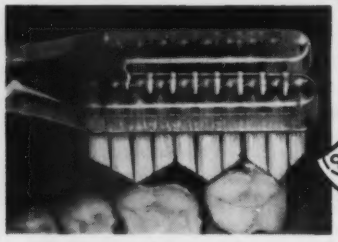
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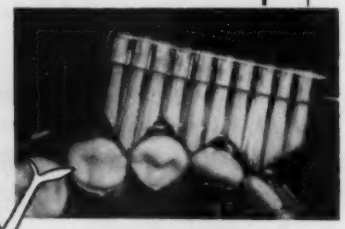
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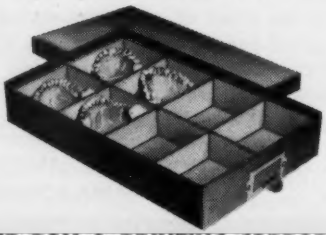
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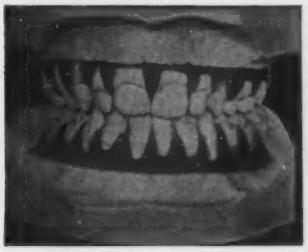
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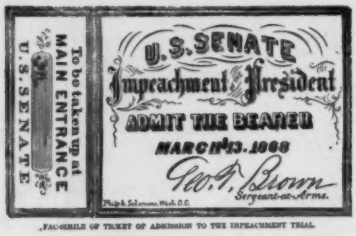
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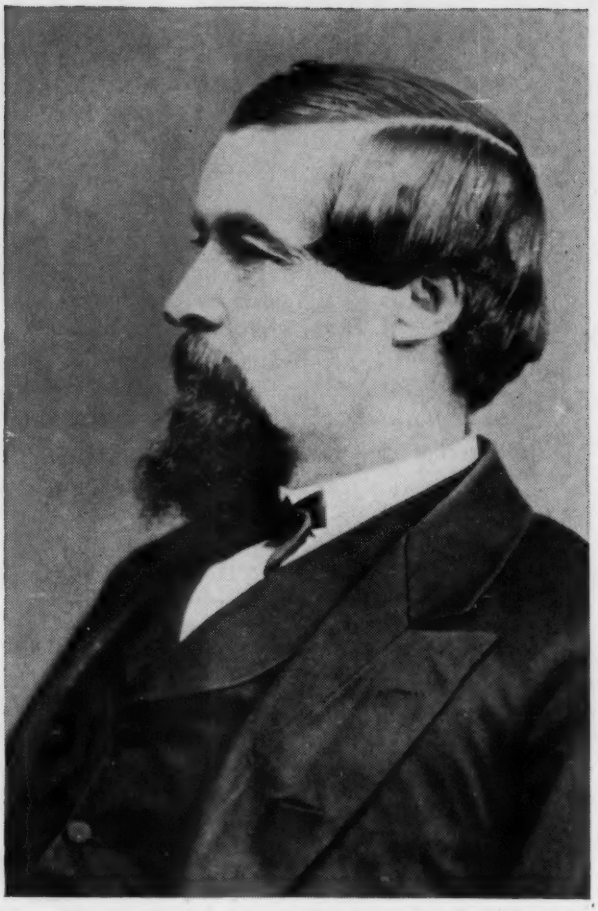
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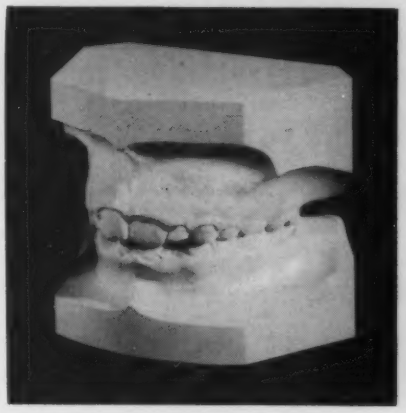
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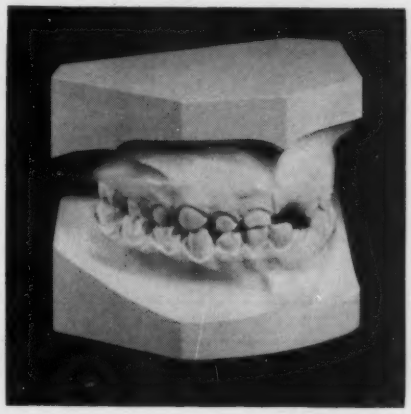
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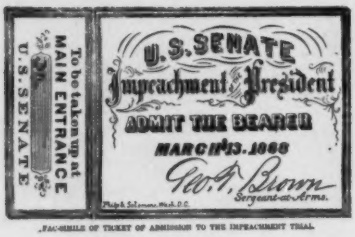
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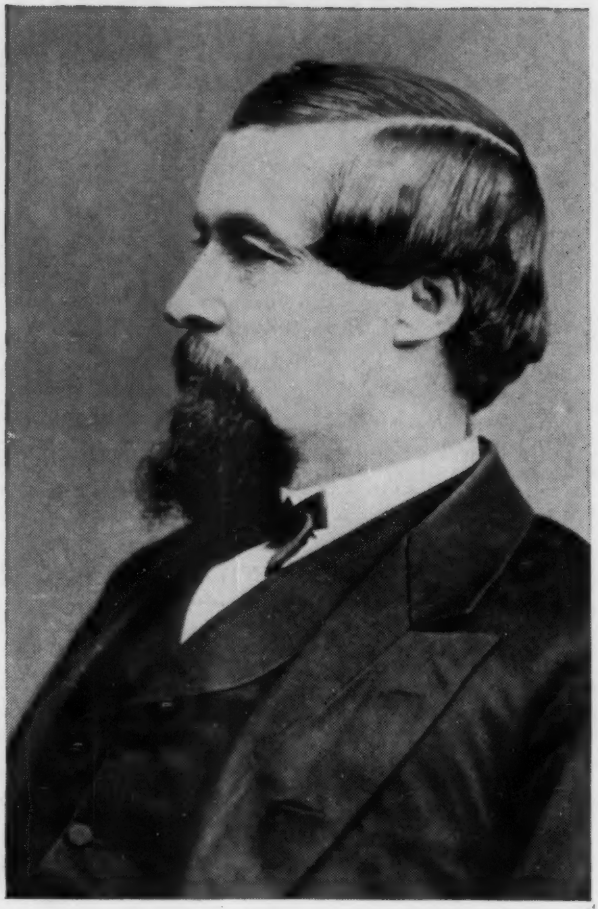
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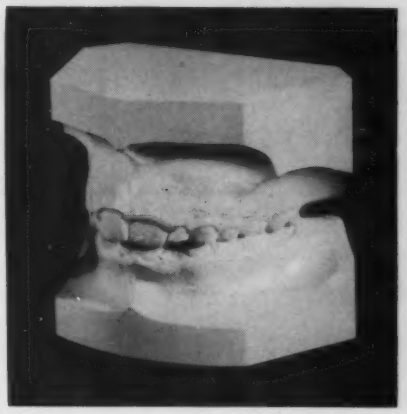
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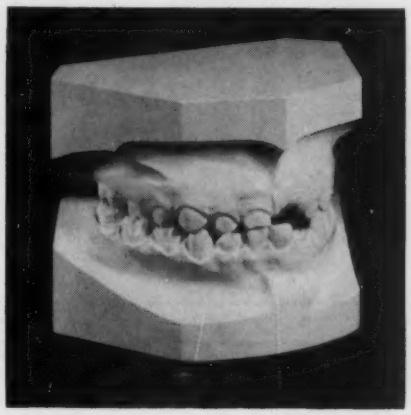
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